Viability Status of Oregon Salmon and Steelhead Populations in the Willamette and Lower Columbia Basins

Part 5: Lower Columbia Steelhead

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I. ESU Overview and Historical Range

Five populations of winter steelhead and one population of summer steelhead exist in Oregon's portion of the LCR ESU (Figures 1 and 2). Two populations belong to the cascade winter stratum (Clackamas and Sandy), three populations represent the winter steelhead gorge stratum Lower Gorge, Upper Gorge, and Hood River. The two Gorge populations exist both Oregon and Washington. In addition, the sole summer steelhead population for this ESU in Oregon occurs in the Hood River (gorge summer steelhead stratum). (Myers et al. 2006, McElhany et al. 2003).

In general, wild steelhead in the lower Columbia basin, although depressed from historical levels, are thought to exist in most of their historical range. Unlike coho and Chinook, all historical populations of steelhead are all believed to be extant. However, up until recent years the presence of naturally spawning hatchery fish in most populations has been high.

The presentation of our assessment begins with three sections, each of which evaluates one of the viability criteria (i.e., abundance/productivity, spatial structure, and diversity). The methods are described in Part 1 of this report. This is then followed by a synthesis section where we pool the results from these criteria evaluations into a status rating for each population. We end our presentation with an interpretation of the population results in terms of the overall status of Oregon's LCR steelhead populations.

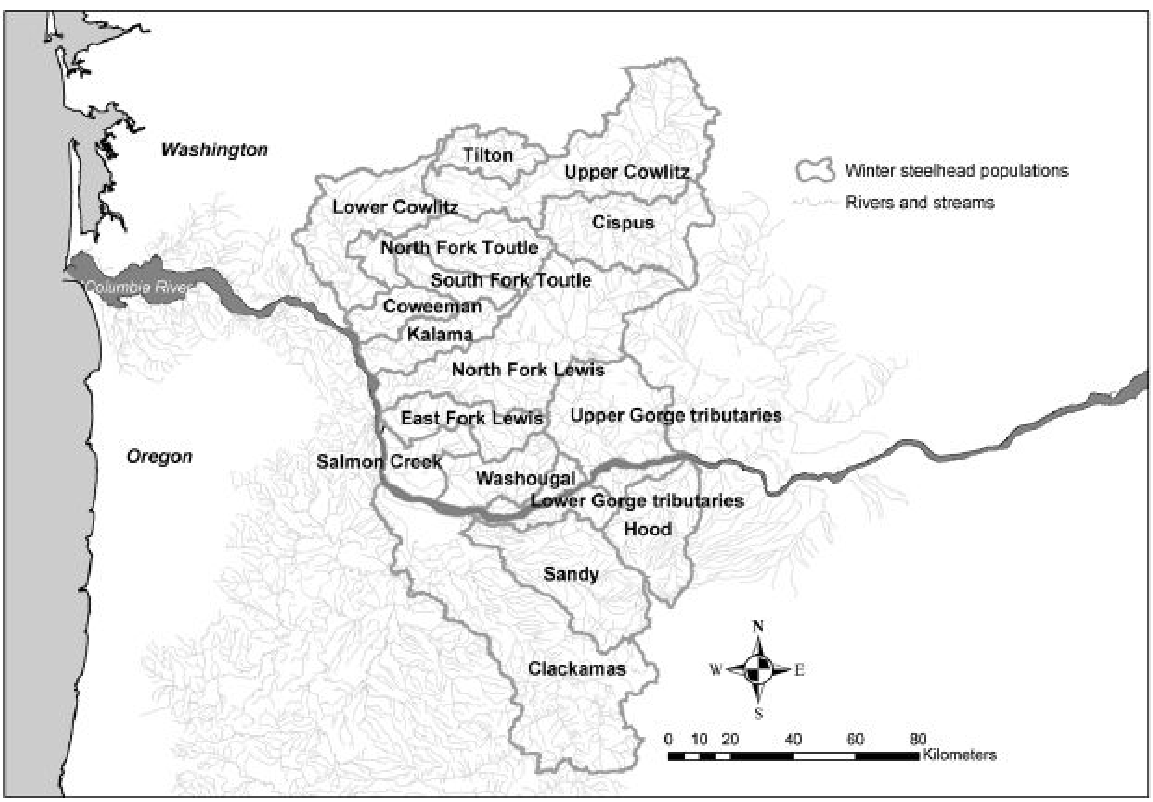

Figure 1: Map of LCR winter steelhead populations (Myers et al. 2006).

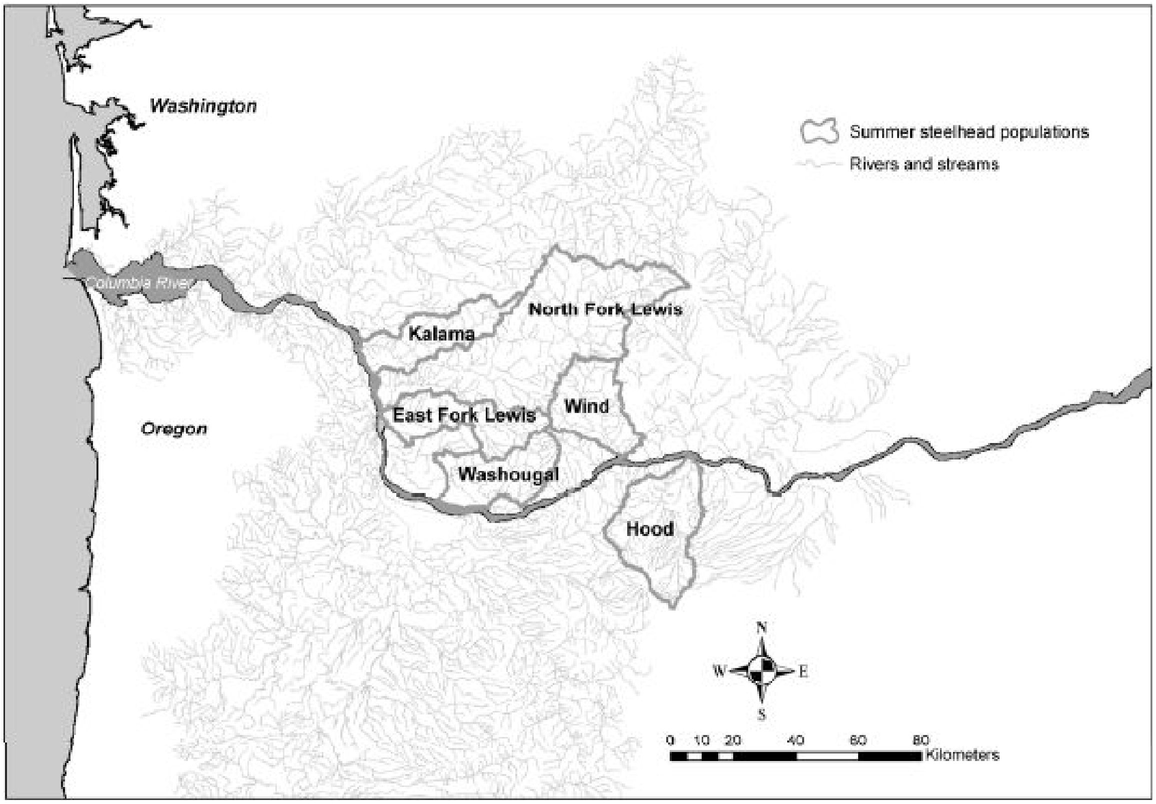

Figure 2: Map of LCR summer steelhead populations (Myers et al. 2006).

II. Abundance and Productivity

A&P - Clackamas Winter Steelhead

A time series of abundance sufficient for quantitative analysis is available for the Clackamas winter steelhead population (Appendix B). Descriptive graphs and viability analysis results are provided in Figure 3 to Figure 9 and in Table 1 to Table 4. The population long-term geometric mean is about 1,800 natural origin spawners, which is in the very low risk minimum abundance threshold category (Table 1). The average recent hatchery fraction is estimated at about 25%, making it difficult to obtain a precise estimate of population productivity for wild fish only. The pre-harvest viability curve analysis, the CAPM modeling and PopCycle all suggest that the population is currently at low risk (viable) or at very low risk. The escapement viability curve suggests that a population experiencing the pattern of harvest that occurred over the available time series, when the average fishery mortality rate averaged 42%, would most likely be in the high to moderate risk category. The Oregon Native Fish Status report (ODFW 2005) listed the Clackamas winter steelhead population as a “pass” for abundance and a “pass” for productivity.

Although the quantitative analysis of recent time series suggests that this population may be viable, the future impacts of human population growth and climate change add a degree of uncertainty to this result. Therefore, we conclude that the population is most likely in the low risk (viable) category, but with the possibility of being in either the very low risk or the high risk categories.

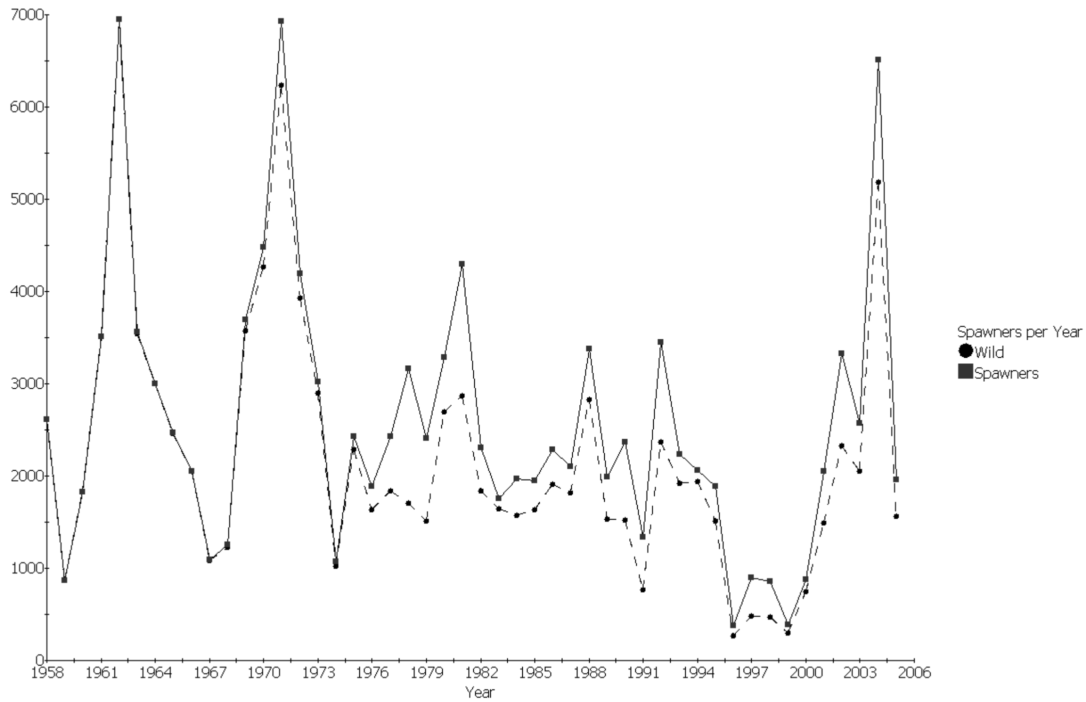

Figure 3: Clackamas Winter Steelhead abundance.

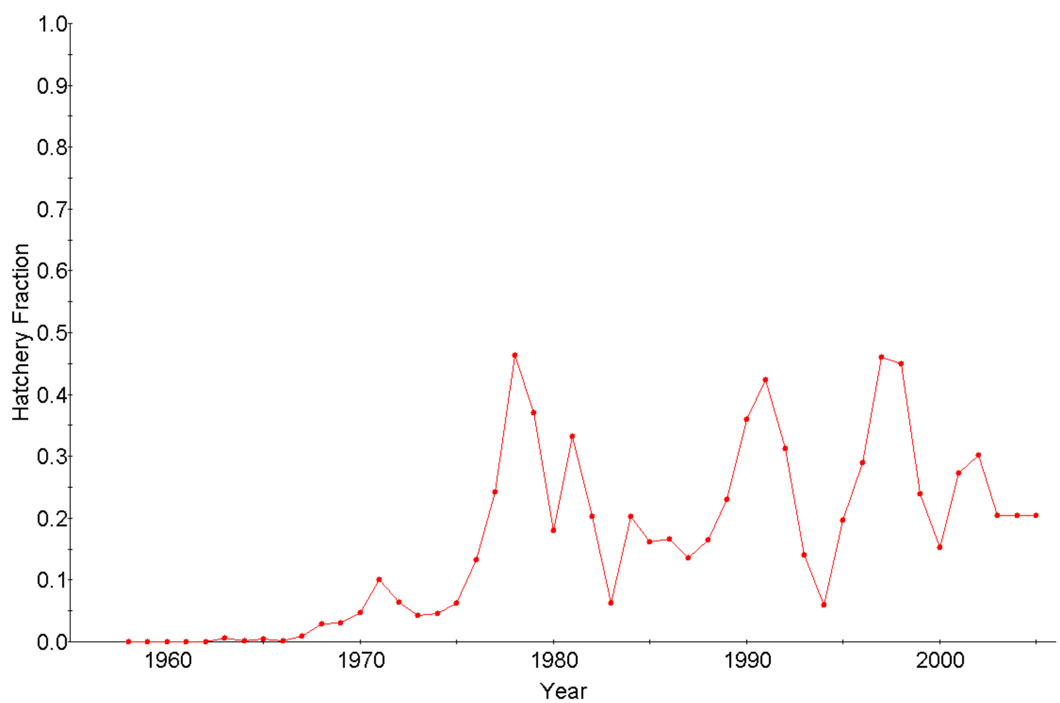

Figure 4: Clackamas Winter Steelhead hatchery fraction.

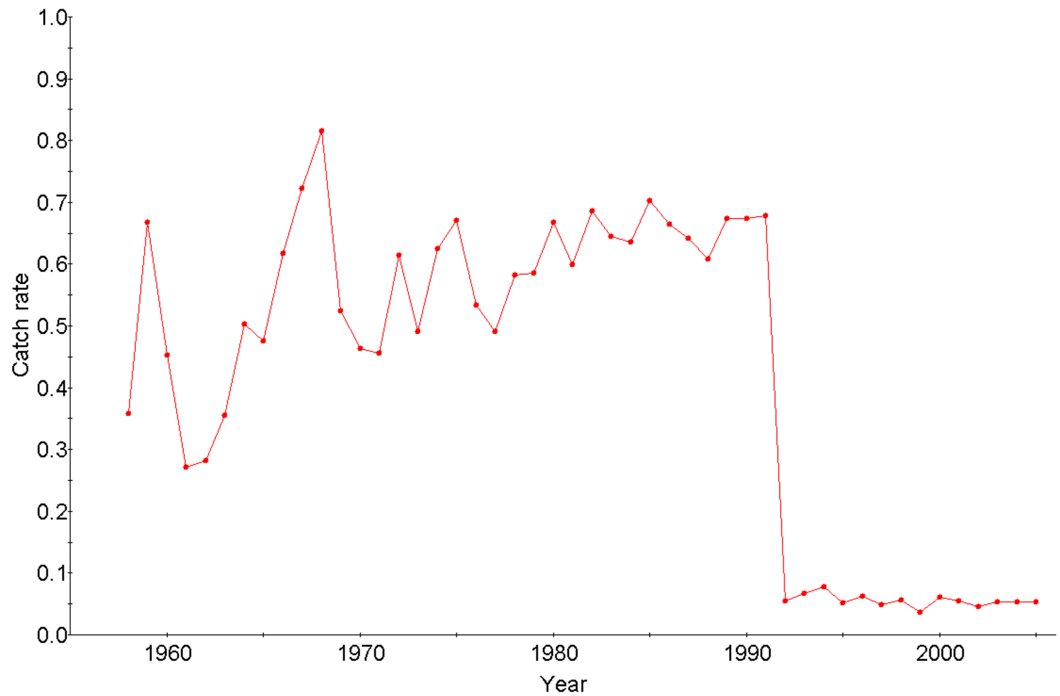

Figure 5: Clackamas Winter Steelhead harvest rate

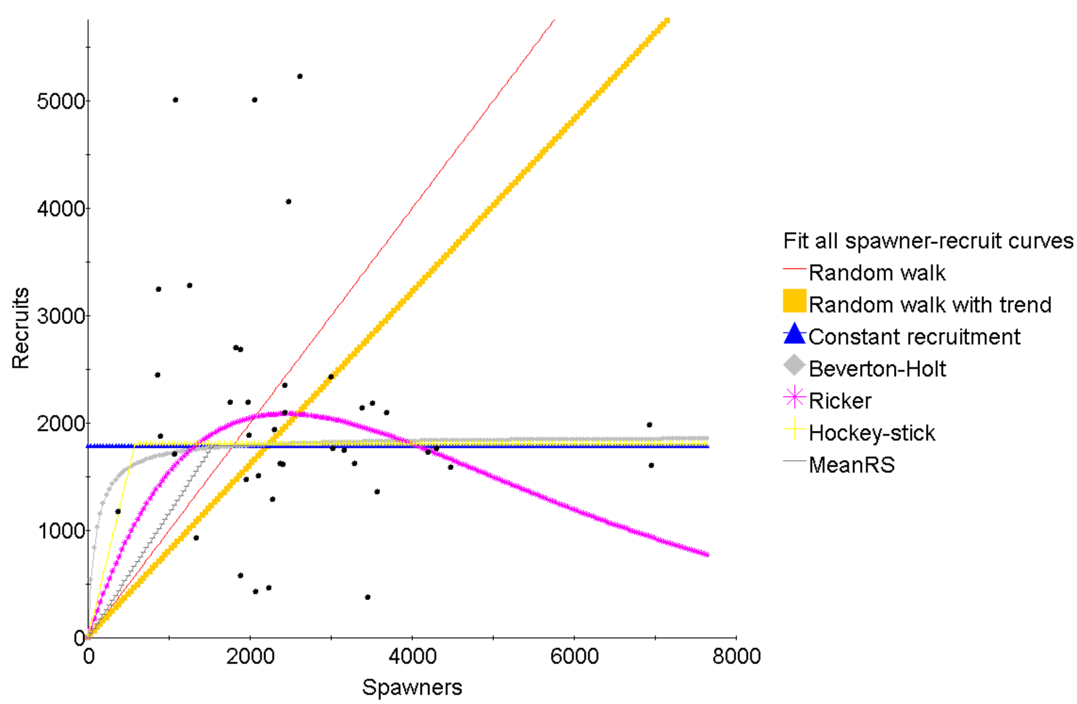

Figure 6: Clackamas Winter Steelhead escapement recruitment functions.

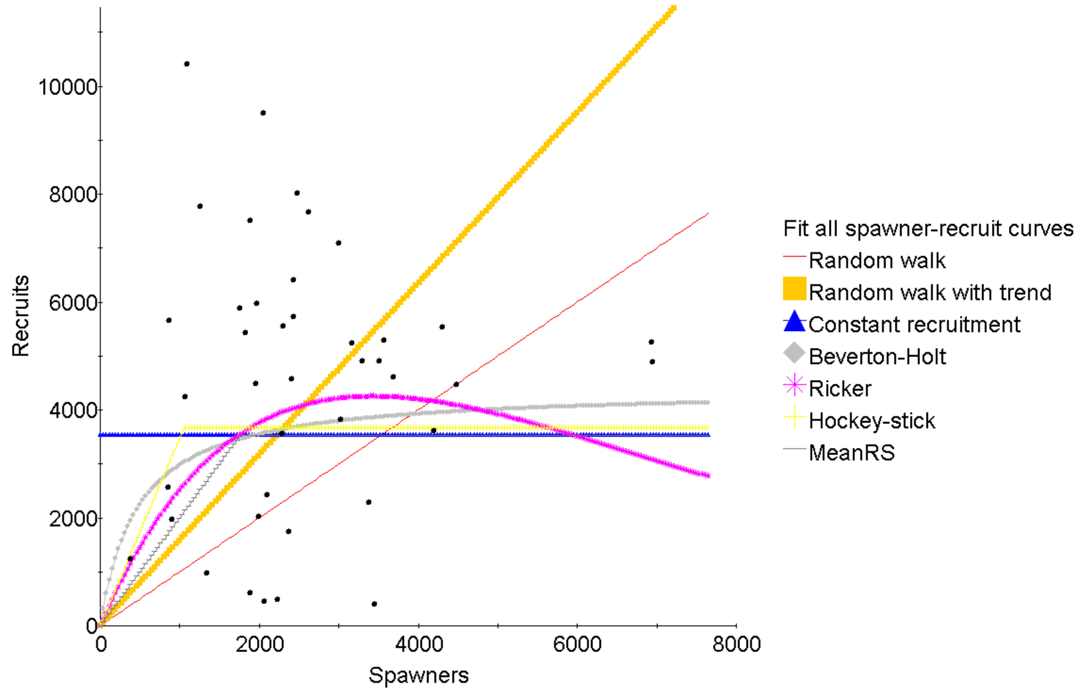

Figure 7: Clackamas Winter Steelhead pre-harvest recruitment functions.

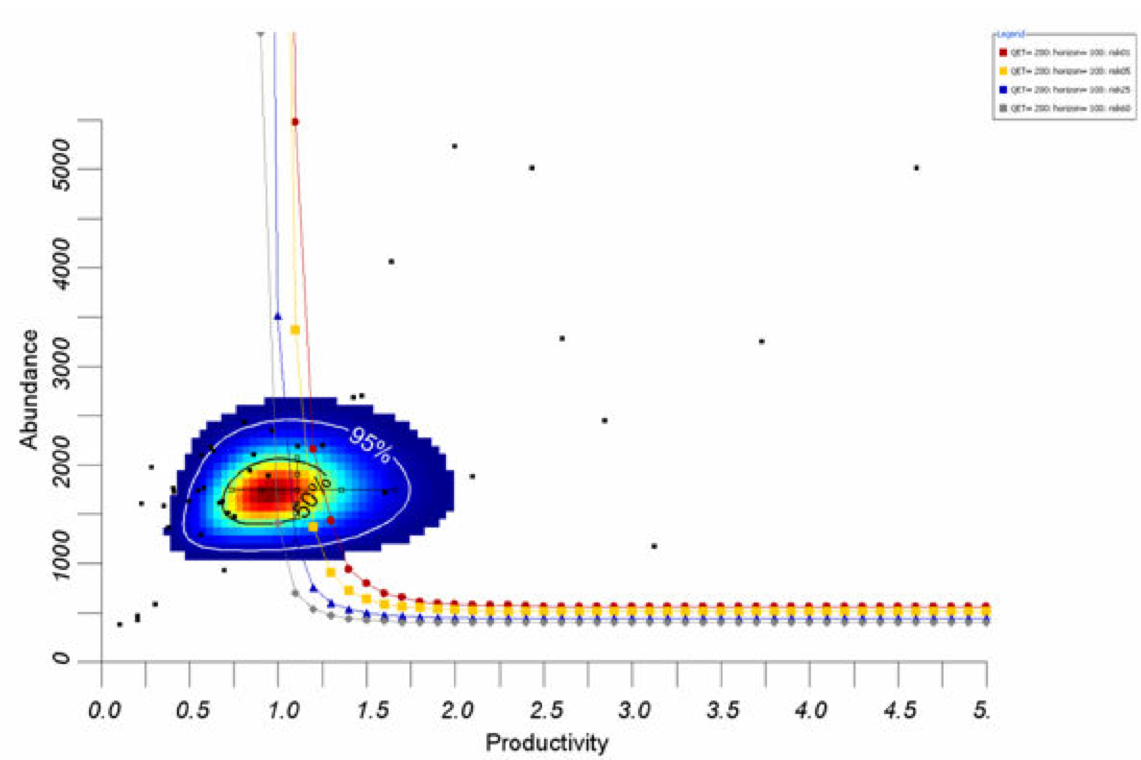

Figure 8: Clackamas Winter Steelhead escapement viability curves.

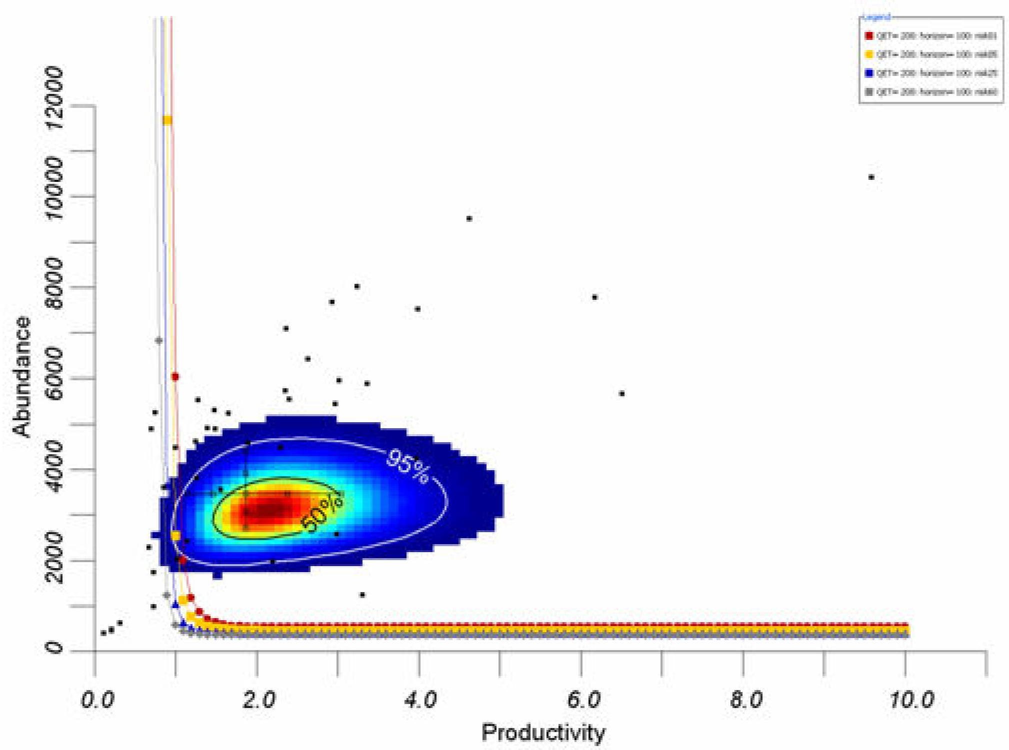

Figure 9: Clackamas Winter Steelhead pre-harvest viability curves.

Table 1: Clackamas Winter Steelhead summary statistics. The 95% confidence intervals are shown in parentheses.

Statistic	Escapement		Pre-harvest	
	Total Series	**Recent Years**	**Total Series**	**Recent Years**
Time Series Period	1958 - 2005	1990 - 2005	1958 - 2005	1990 - 2005
Length of Time Series	48	16	48	16
Geometric Mean Natural Origin Spawner Abundance	1793 (1469 - 2189)	1168 (750 - 1818)	1793 (1469 - 2189)	1168 (750 - 1818)
Geometric Mean Recruit Abundance	1793 (1488 - 2160)	892 (521 - 1525)	3536 (2711 - 4614)	943 (551 - 1613)
Lambda	0.964 (0.851 - 1.091)	0.976 (0.432 - 2.205)	1.101 (0.953 - 1.272)	0.96 (0.413 - 2.228)
Trend in Log Abundance	0.98 (0.967 - 0.993)	1.03 (0.934 - 1.137)	0.98 (0.967 - 0.993)	1.03 (0.934 - 1.137)
Geometric Mean Recruits per Spawner (all broods)	0.804 (0.613 - 1.054)	0.617 (0.238 - 1.603)	1.585 (1.177 - 2.134)	0.652 (0.251 - 1.695)
Geometric Mean Recruits per Spawner (broods < median spawner abundance)	1.177 (0.769 - 1.801)	1.321 (0.378 - 4.618)	1.985 (1.19 - 3.312)	1.393 (0.399 - 4.869)
Average Hatchery Fraction	0.162	0.267	0.162	0.267
Average Harvest Rate	0.421	0.133	0.421	0.133
CAPM median extinction risk probability (5th and 95th percentiles in parenthesis)	NA	NA	0.000 (0.000 -0.030)	NA
PopCycle extinction risk	NA	NA	0.02	NA

Table 2: Escapement recruitment parameter estimates and relative AIC values for Clackamas winter steelhead. The 95% probability intervals on parameters are shown in parentheses. The model that is the "best" approximation (i.e., relative AIC = 0) is shown in bright green. Models that nearly indistinguishable from best (i.e., relative AIC <2) are shown in darker green. Models that are possible, but less likely, contenders as best (i.e., 2 < relative AIC < 10) are shown in yellow. Models that are very unlikely to be the best approximating model (i.e., relative AIC > 10) are not highlighted (i.e., white background).

Model	Productivity	Capacity	Variance	Relative AIC
Random walk	NA	NA	0.88 (0.75-1.09)	31.4
Random walk with trend	0.8 (0.65-1.03)	NA	0.85 (0.74-1.07)	30.7
Constant recruitment	NA	1793 (1543-2114)	0.58 (0.5-0.74)	0
Beverton-Holt	>20 (5.17->20)	1880 (1651-2407)	0.59 (0.51-0.74)	2.4
Ricker	2.32 (1.62-3.47)	2084 (1816-2608)	0.63 (0.55-0.81)	8.4
Hockey-stick	3.1 (2.61->20)	1810 (1544-2133)	0.58 (0.51-0.74)	1.5
MeanRS	1.16 (0.84-1.57)	1793 (1539-2075)	0.44 (0.25-0.62)	31.1

Table 3: Preharvest recruitment parameter estimates and relative AIC values for Clackamas winter steelhead. The 95% probability intervals on parameters are shown in parentheses. The model that is the "best" approximation (i.e., relative AIC = 0) is shown in bright green. Models that nearly indistinguishable from best (i.e., relative AIC <2) are shown in darker green. Models that are possible, but less likely, contenders as best (i.e., 2 < relative AIC < 10) are shown in yellow. Models that are very unlikely to be the best approximating model (i.e., relative AIC > 10) are not highlighted (i.e., white background).

Model	Productivity	Capacity	Variance	Relative AIC
Random walk	NA	NA	1.04 (0.89-1.3)	16.2
Random walk with trend	1.58 (1.27-2.09)	NA	0.93 (0.81-1.18)	9.2
Constant recruitment	NA	3539 (2867-4533)	0.83 (0.72-1.05)	0
Beverton-Holt	9.27 (3.2-18.86)	4403 (3387-8163)	0.82 (0.71-1.04)	0.8
Ricker	3.38 (1.83-5.44)	4254 (3598-12145)	0.84 (0.74-1.09)	2.8
Hockey-stick	3.48 (2.96-18.83)	3676 (2912-4657)	0.81 (0.72-1.05)	0.2
MeanRS	2 (1.37-2.87)	3536 (2830-4337)	0.74 (0.38-1.07)	6.6

Table 4Clackamas winter steelhead CAPM risk category and viability curve results.

Risk Category	Viability Curves - Escapement	Viability Curves - Preharvest	CAPM
Probability the population is	0.558	0.999	1.000

not in “Extirpated or nearly so” category			
Probability the population is above “Moderate risk of extinction” category	0.431	0.998	0.993
Probability the population is above “Viable” category	0.295	0.995	0.617
Probability the population is above “Very low risk of extinction” category	0.220	0.994	0.363

A&P - Sandy Winter

A time series of abundance sufficient for quantitative analysis is available for the Sandy winter steelhead population (Appendix B). Descriptive graphs and viability analysis results are provided in Figure 10 to Figure 16 and in Table 5 to Table 8. The population long-term geometric mean is about 850 natural origin spawners, which is in the viable minimum abundance threshold category (Table 5). However, the population shows very low productivity. The pre-harvest viability curve analysis, PopCycle, and the CAPM modeling all suggest that the population is currently at very high risk, falling into the “extirpated or nearly so” category. The escapement viability curve suggests that if the population continued experiencing the pattern of harvest that occurred over the available time series (average fisheries mortality rate = 0.39), it would most likely be in the extirpated or nearly so risk category. Over much of the time series, the populations has had a relatively high fraction of hatchery origin spawners, making estimation of the true productivity problematic Figure 11. The Oregon Native Fish Status report (ODFW 2005) listed the Sandy winter steelhead population as a “pass” for abundance and a “fail” for productivity. Considering the available information, we consider the population most likely in the high risk category or nearly extirpated.

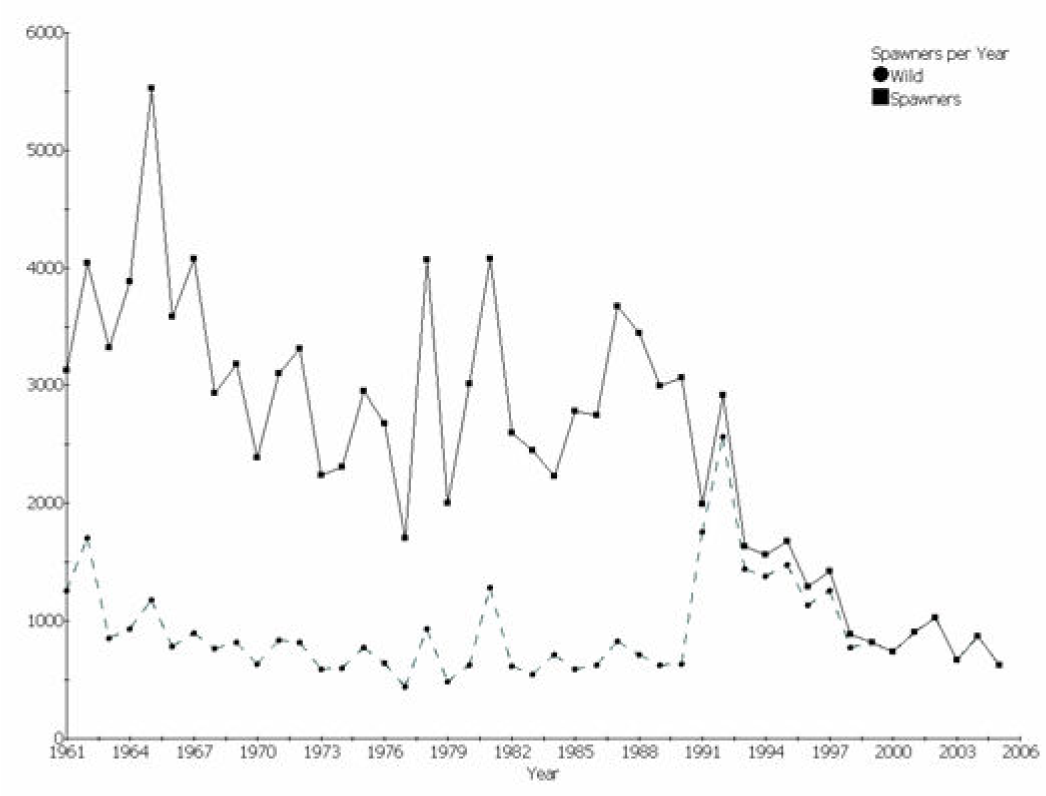

Figure 10: Sandy Winter Steelhead abundance.

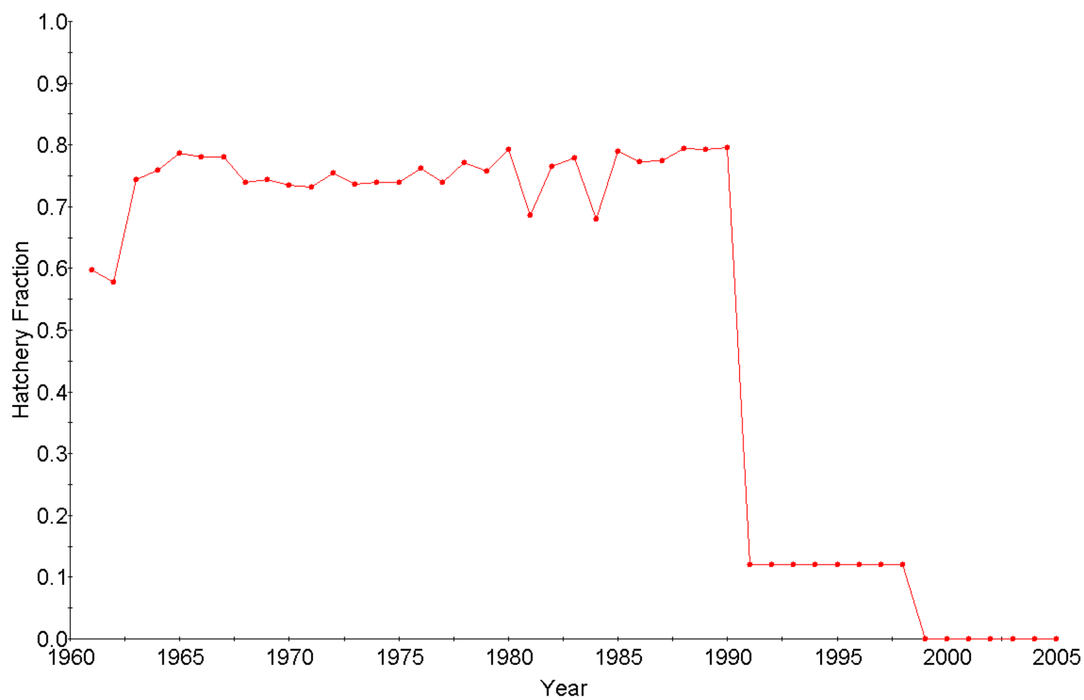

Figure 11: Sandy Winter Steelhead hatchery fraction.

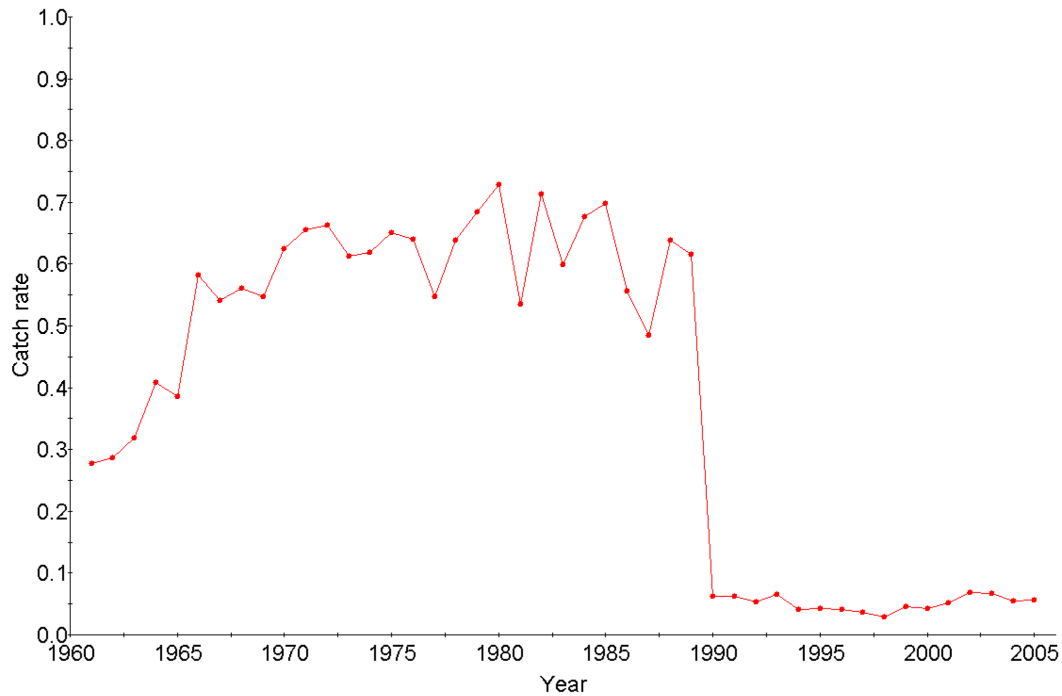

Figure 12: Sandy Winter Steelhead harvest rate

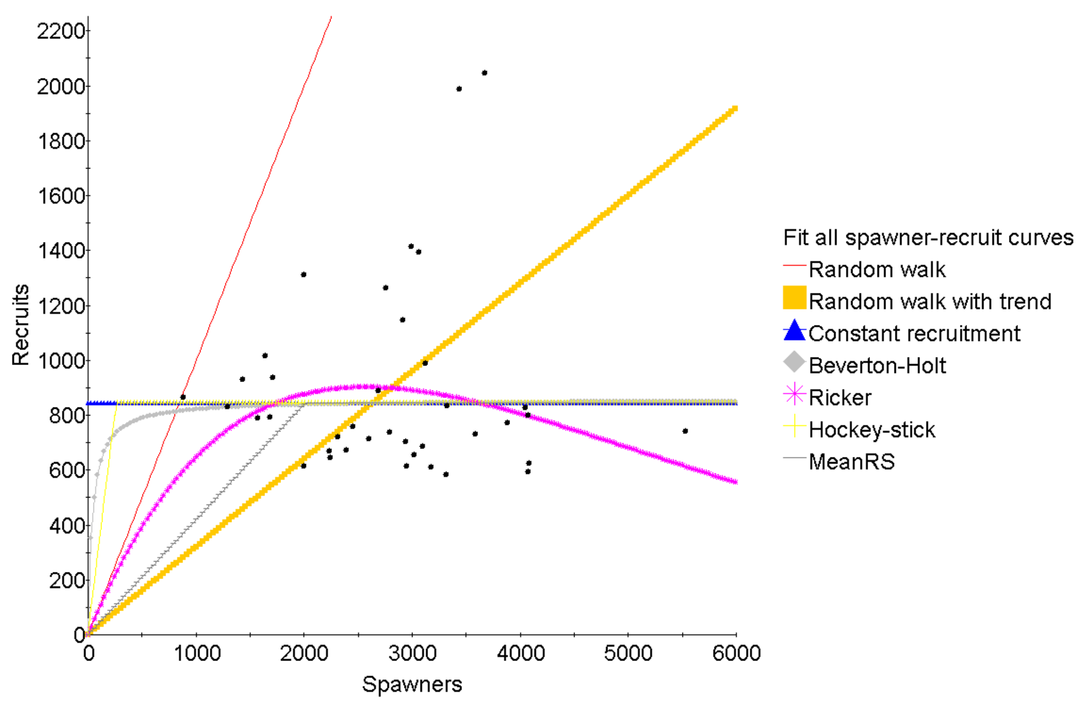

Figure 13: Sandy Winter Steelhead escapement recruitment functions.

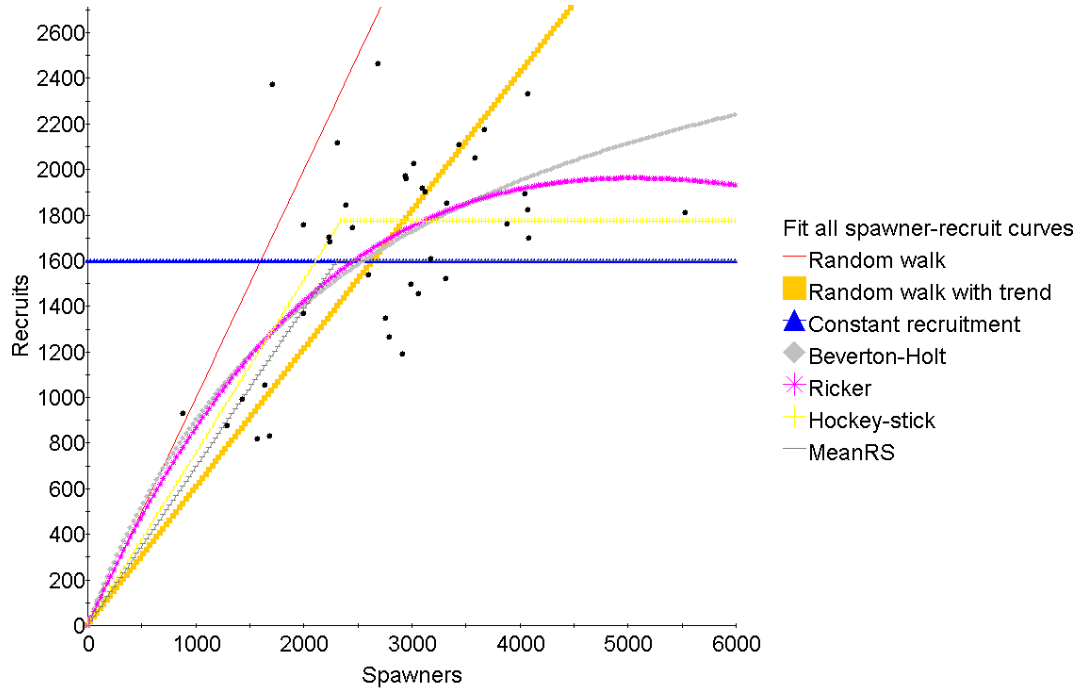

Figure 14: Sandy Winter Steelhead pre-harvest recruitment functions.

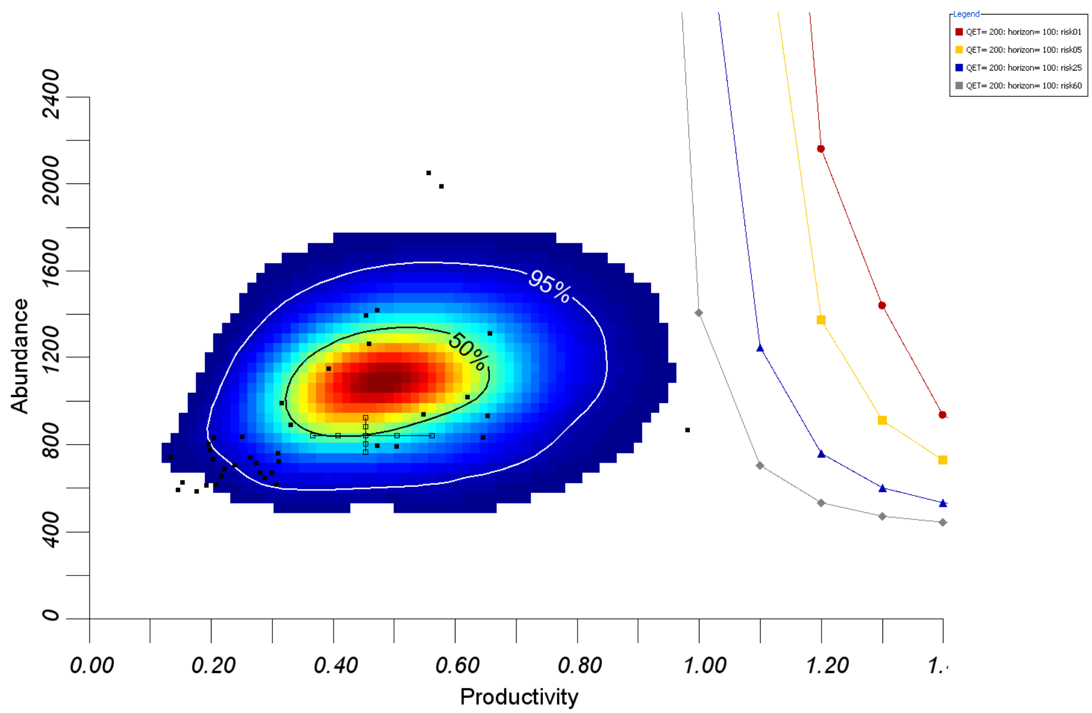

Figure 15: Sandy Winter Steelhead escapement viability curve.

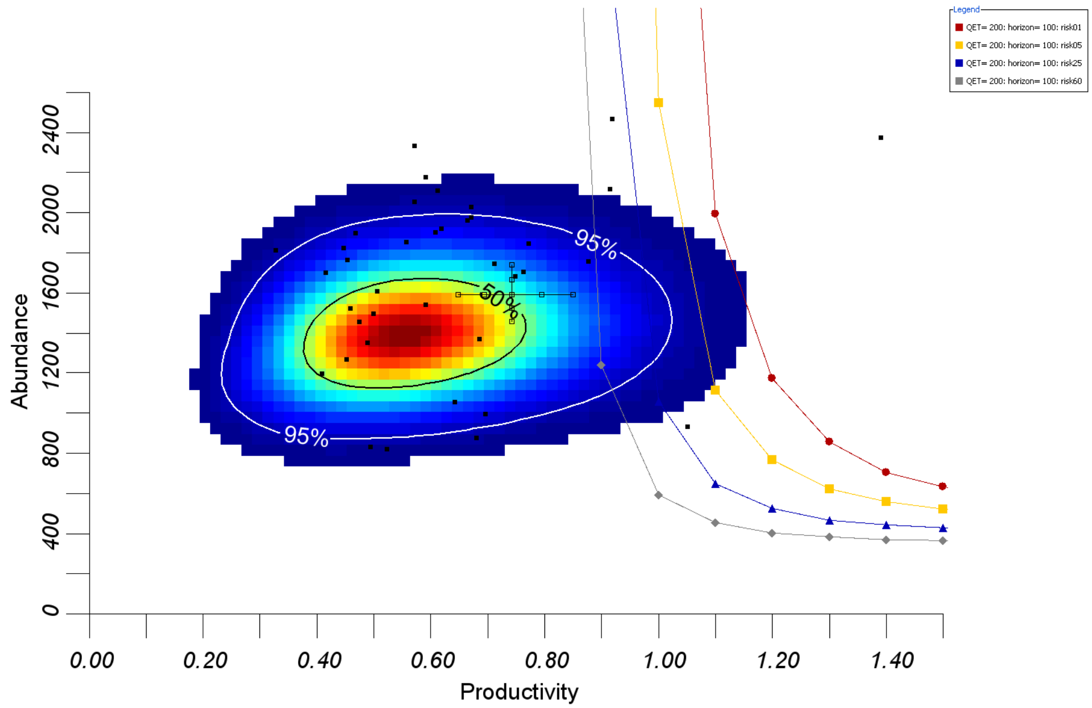

Figure 16: Sandy Winter Steelhead pre-harvest viability curve.

Table 5: Sandy Winter Steelhead summary statistics. The 95% confidence intervals are shown in parentheses.

Statistic	Escapement		Pre-harvest	
	Total Series	Recent Years	Total Series	Recent Years
Time Series Period	1961 - 2005	1990 - 2005	1961 - 2005	1990 - 2005
Length of Time Series	45	16	45	16
Geometric Mean Natural Origin Spawner Abundance	849 (759 - 949)	1040 (838 - 1290)	849 (759 - 949)	1040 (838 - 1290)
Geometric Mean Recruit Abundance	845 (762 - 937)	988 (838 - 1165)	1600 (1451 - 1765)	1036 (881 - 1218)
Lambda	0.798 (0.72 - 0.884)	0.923 (0.794 - 1.072)	0.906 (0.873 - 0.941)	0.933 (0.793 - 1.097)
Trend in Log Abundance	1.002 (0.994 - 1.011)	0.95 (0.914 - 0.987)	1.002 (0.994 - 1.011)	0.95 (0.914 - 0.987)
Geometric Mean Recruits per Spawner (all broods)	0.32 (0.272-0.376)	0.578 (0.469 -0.713)	0.606 (0.551 - 0.666)	0.606 (0.488 - 0.752)
Geometric Mean Recruits per Spawner (broods < median spawner abundance)	0.439 (0.349 - 0.553)	0.676 (0.547 - 0.836)	0.744 (0.643 - 0.861)	0.715 (0.573 - 0.892)
Average Hatchery	0.519		0.519	0.110

Fraction		0.110		
Average Harvest Rate	0.385	0.051	0.385	0.051
CAPM median extinction risk probability (5th and 95th percentiles in parenthesis)	NA	NA	0.910 (0.345-1.000)	NA
PopCycle extinction risk	NA	NA	0.97	NA

Table 6: Escapement recruitment parameter estimates and relative AIC values for Sandy winter steelhead. The 95% probability intervals on parameters are shown in parentheses. The model that is the "best" approximation (i.e., relative AIC = 0) is shown in bright green. Models that nearly indistinguishable from best (i.e., relative AIC <2) are shown in darker green. Models that are possible, but less likely, contenders as best (i.e., 2 < relative AIC < 10) are shown in yellow. Models that are very unlikely to be the best approximating model (i.e., relative AIC > 10) are not highlighted (i.e., white background).

Model	Productivity	Capacity	Variance	Relative AIC
Random walk	NA	NA	1.24 (1.06-1.56)	103
Random walk with trend	0.32 (0.28-0.37)	NA	0.49 (0.42-0.63)	34.3
Constant recruitment	NA	845 (776-924)	0.31 (0.27-0.4)	0
Beverton-Holt	>20 (2.96->20)	858 (801-993)	0.31 (0.27-0.4)	2.1
Ricker	0.95 (0.72-1.3)	902 (837-1020)	0.32 (0.28-0.42)	4.5
Hockey-stick	3.25 (1.65-19.01)	845 (776-923)	0.31 (0.27-0.4)	2
MeanRS	0.42 (0.36-0.49)	845 (779-920)	0.13 (0.08-0.17)	189.7

Table 7: Preharvest recruitment parameter estimates and relative AIC values for Sandy winter steelhead. The 95% probability intervals on parameters are shown in parentheses. The model that is the "best" approximation (i.e., relative AIC = 0) is shown in bright green. Models that nearly indistinguishable from best (i.e., relative AIC <2) are shown in darker green. Models that are possible, but less likely, contenders as best (i.e., 2 < relative AIC < 10) are shown in yellow. Models that are very unlikely to be the best approximating model (i.e., relative AIC > 10) are not highlighted (i.e., white background).

Model	Productivity	Capacity	Variance	Relative AIC
Random walk	NA	NA	0.58 (0.49-0.72)	71.9
Random walk with trend	0.61 (0.56-0.66)	NA	0.28 (0.24-0.36)	20.1
Constant recruitment	NA	1600 (1477-1743)	0.29 (0.25-0.38)	22.7
Beverton-Holt	1.26 (0.91-1.99)	3189 (2346-5013)	0.22 (0.19-0.28)	1.7
Ricker	1.06 (0.84-1.27)	1962 (1761-2618)	0.21 (0.19-0.28)	0.6
Hockey-stick	0.76 (0.68-0.86)	1772 (1657-1927)	0.21 (0.19-0.28)	0

MeanRS	0.69 (0.62-0.78)	1600 (1478-1724)	0.05 (0.03-0.07)	811.9

Table 8: Sandy winter steelhead CAPM risk category and viability curve results.

Risk Category	Viability Curves - Escapement	Viability Curves - Preharvest	CAPM
Probability the population is not in “Extirpated or nearly so” category	0.000	0.051	0.113
Probability the population is above “Moderate risk of extinction” category	0.000	0.019	0.058
Probability the population is above “Viable” category	0.000	0.006	0.005
Probability the population is above “Very low risk of extinction” category	0.000	0.002	0.000

A&P - Lower Gorge Winter

A time series of abundance is not available for the Lower Gorge winter steelhead population. In the native fish report, ODFW treated the lower and upper gorge as a single ‘gorge’ population. They then assumed that this single gorge population was similar to the Hood winter steelhead population and gave it a ‘pass’ for both abundance and productivity. We assume that the lower gorge population is most similar to the Sandy population, only at lower abundance because there is less available habitat. Although, unlike the Sandy the occurrence of naturally spawning hatchery fish has likely been much less of a factor because the nearest steelhead smolt release sites are the Sandy basin and the Hood River. However, given the lack of information and the adverse condition of the Sandy population and to a lesser extent the Hood population, we believe the lower gorge winter steelhead most likely qualifies for the moderate risk category.

A&P - Upper Gorge Winter

A time series of abundance is not available for the Upper Gorge winter steelhead population. In the native fish report, ODFW treated the lower and upper gorge as a single ‘gorge’ population. They then assumed that this single gorge population was similar to the Hood winter steelhead population and gave it a ‘pass’ for both abundance and productivity. We assume that the upper gorge population is most similar to the Hood winter population (see below), only at lower abundance because there is less available habitat. We therefore consider the upper gorge winter steelhead to be most likely in the moderate category, but with some possibility of being in either the viable or nearly extirpated categories.

A&P - Hood Winter

A short time series of abundance starting in 1992 is available for the Hood winter steelhead population based on counts at Powerdale dam (see appendix B). Descriptive graphs and viability analysis results are provided in Figure 17 to Figure 21 and in Table 9 to Table 11. The population long-term geometric mean is about 400 natural origin spawners, which is in the moderate risk minimum abundance threshold category. The time series is too short for a viability curve, CAPM, or PopCycle analysis. The time series is also probably too short for a meaningful recruit per spawner evaluation (only 7 data points), but the graphs and statistics are presented below for consideration. Three of the recruit per spawner estimates are below replacement and four are above. The data contain little information on the relationship between recruits and spawners (Table 10 and Table 11). Based on this scant information, we consider the population most likely in the moderate risk category, but with considerable uncertainty. The Oregon Native Fish Status report (ODFW 2005) listed the Sandy winter steelhead population as a “pass” for abundance and a “pass” for productivity.

Figure 17: Hood winter steelhead abundance at Powerdale dam.

Figure 18: Hood winter steelhead hatchery fraction.

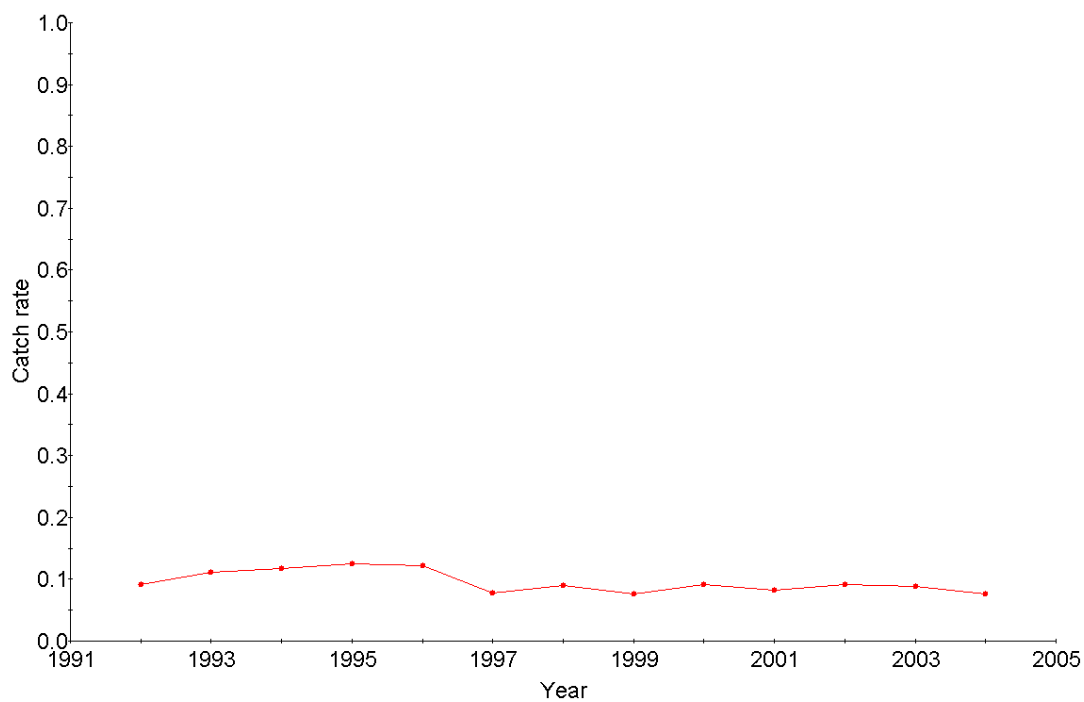

Figure 19: Hood winter steelhead harvest rate.

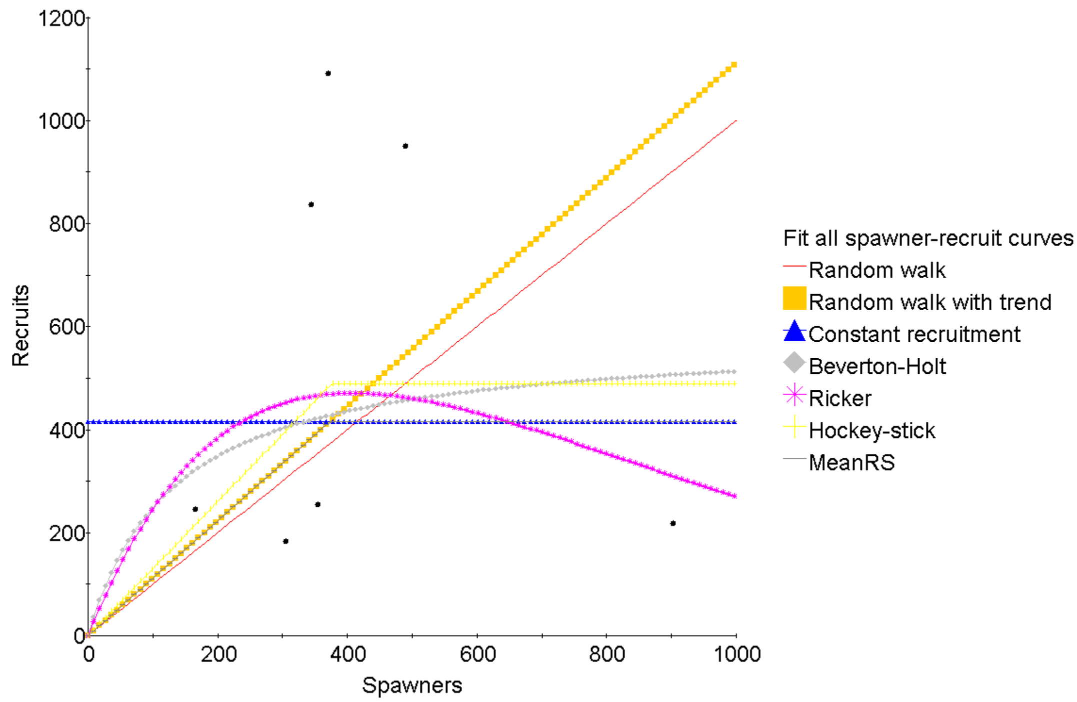

Figure 20: Hood winter steelhead escapement recruitment functions.

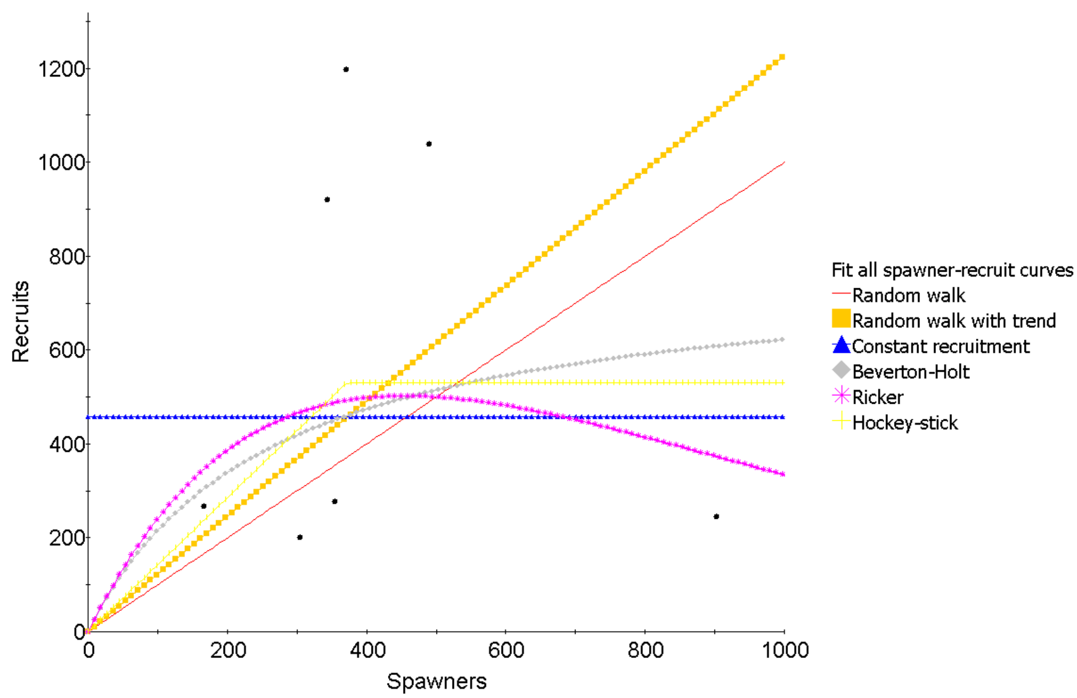

Figure 21: Hood winter steelhead preharvest recruitment functions.

Table 9: Hood winter steelhead summary statistics.

Statistic	Total Series	Total Series
Time Series Period	1992 - 2004	1992 - 2004

Length of Time Series	13	13
Geometric Mean Natural Origin Spawner Abundance	395 (269 - 581)	NA
Geometric Mean Recruit Abundance	416 (201 - 861)	457 (221 - 945)
Lambda	0.985	1.007
Trend in Log Abundance	1.083 (0.987 - 1.19)	NA
Geometric Mean Recruits per Spawner (all broods)	1.115 (0.486 - 2.558)	1.224 (0.537 - 2.792)
Geometric Mean Recruits per Spawner (broods < median spawner abudance)	1.292 (0.671 - 2.487)	1.413 (0.733 - 2.724)
Average Hatchery Fraction	0.3228	NA
Average Harvest Rate	0.0953	NA
SPMPC extinction risk (boot strap intervals are ± 10%)	NA	NA

Table 10: Escapement recruitment parameter estimates and relative AIC values for Hood winter steelhead. The 95% probability intervals on parameters are shown in parentheses. The model that is the "best" approximation (i.e., relative AIC = 0) is shown in bright green. Models that nearly indistinguishable from best (i.e., relative AIC <2) are shown in darker green. Models that are possible, but less likely, contenders as best (i.e., 2 < relative AIC < 10) are shown in yellow. Models that are very unlikely to be the best approximating model (i.e., relative AIC > 10) are not highlighted (i.e., white background).

Model	Productivity	Capacity	Variance	Relative AIC
Random walk	NA	NA	0.84 (0.62-1.71)	0
Random walk with trend	1.11 (0.68-3.29)	NA	0.83 (0.67-2.04)	1.9
Constant recruitment	NA	417 (264-1054)	0.73 (0.58-1.84)	0
Beverton-Holt	4.42 (0.84-16.77)	564 (379-17937)	0.71 (0.61-1.96)	1.7
Ricker	3.05 (0.75-9.97)	471 (475-18534)	0.65 (0.62-1.98)	0.5
Hockey-stick	1.33 (0.77-17.75)	502 (310-18066)	0.67 (0.61-1.96)	0.8
MeanRS	1.12 (0.69-1.79)	416 (268-651)	0.52 (0.16-0.64)	2.5

Table 11: Preharvest recruitment parameter estimates and relative AIC values for Hood winter steelhead. The 95% probability intervals on parameters are shown in parentheses. The model that is the "best" approximation (i.e., relative AIC = 0) is shown in bright green. Models that nearly indistinguishable from best (i.e., relative AIC <2) are shown in darker green. Models that are

possible, but less likely, contenders as best (i.e., 2 < relative AIC < 10) are shown in yellow. Models that are very unlikely to be the best approximating model (i.e., relative AIC > 10) are not highlighted (i.e., white background).

Model	Productivity	Capacity	Variance	Relative AIC
Random walk	NA	NA	0.85 (0.63-1.75)	0.2
Random walk with trend	1.23 (0.75-3.87)	NA	0.83 (0.66-2.09)	1.8
Constant recruitment	NA	459 (291-1162)	0.73 (0.58-1.84)	0
Beverton-Holt	4.46 (1.09-18)	658 (383-8425)	0.71 (0.59-1.86)	1.7
Ricker	3.31 (0.88-13.43)	516 (483-9070)	0.66 (0.6-1.98)	0.6
Hockey-stick	1.39 (0.92->20)	536 (318-8435)	0.67 (0.6-1.91)	0.8
MeanRS	1.22 (0.75-1.97)	457 (295-713)	0.51 (0.16-0.63)	2.6

A&P - Hood Summer

A short time series of abundance starting in 1993 is available for the Hood winter steelhead population based on counts at Powerdale dam (see appendix B). Descriptive graphs and viability analysis results are provided in Figure 22 to Figure 26 and in Table 12 to Table 14. The population long-term geometric mean is about 200 natural origin spawners, which is in the nearly extirpated or high risk minimum abundance threshold category (Table 12). The time series is too short for a viability curve, CAPM or PopCycle analysis. The time series is also probably too short for a meaningful recruit per spawner evaluation (only 7 data points), but the graphs and statistics are presented below for consideration. Six of the seven recruit per spawner estimates are below replacement, suggesting low productivity. The data contain little information on the relationship between recruits and spawners (Table 13 and Table 14). Based on this scant information, we consider the population most likely in the nearly extirpated or high risk category, but with considerable uncertainty. The Oregon Native Fish Status report (ODFW 2005) listed the Hood River summer steelhead population as a “fail” for abundance and a “fail” for productivity.

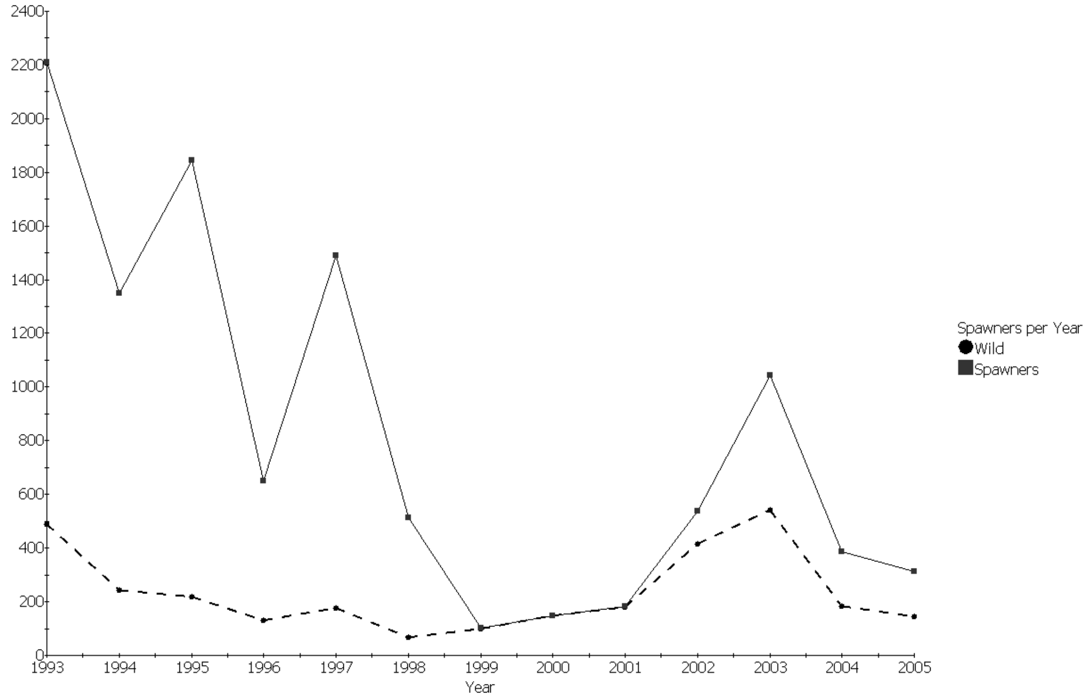

Figure 22: Hood River Summer Steelhead abundance.

Figure 23: Hood River Summer Steelhead hatchery fraction.

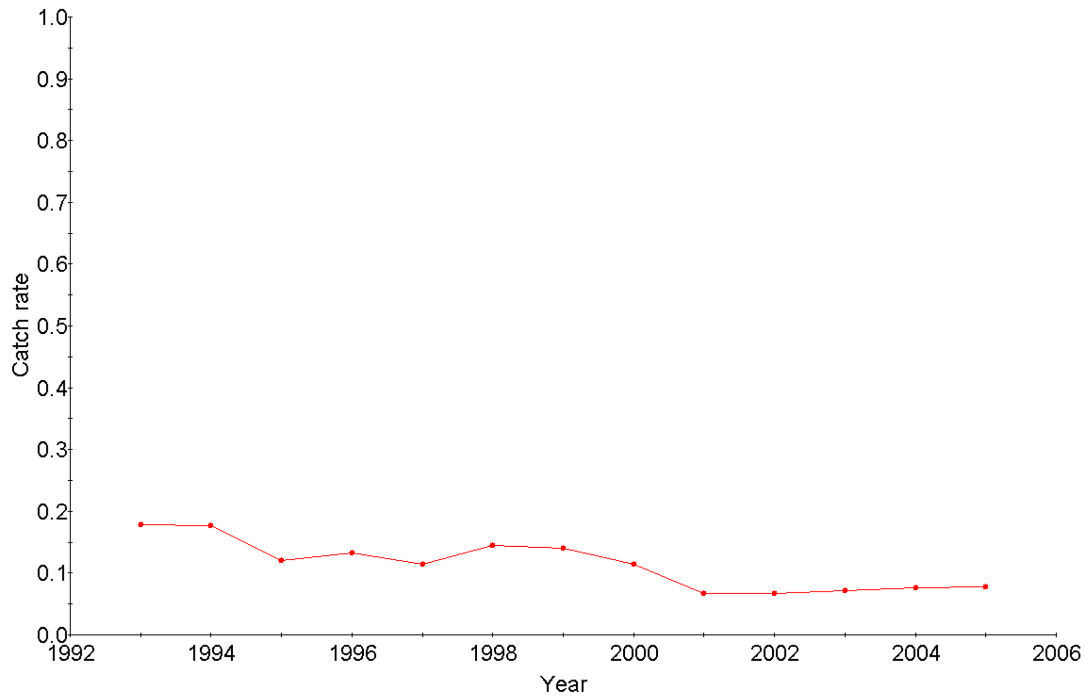

Figure 24: Hood River Summer Steelhead harvest rate

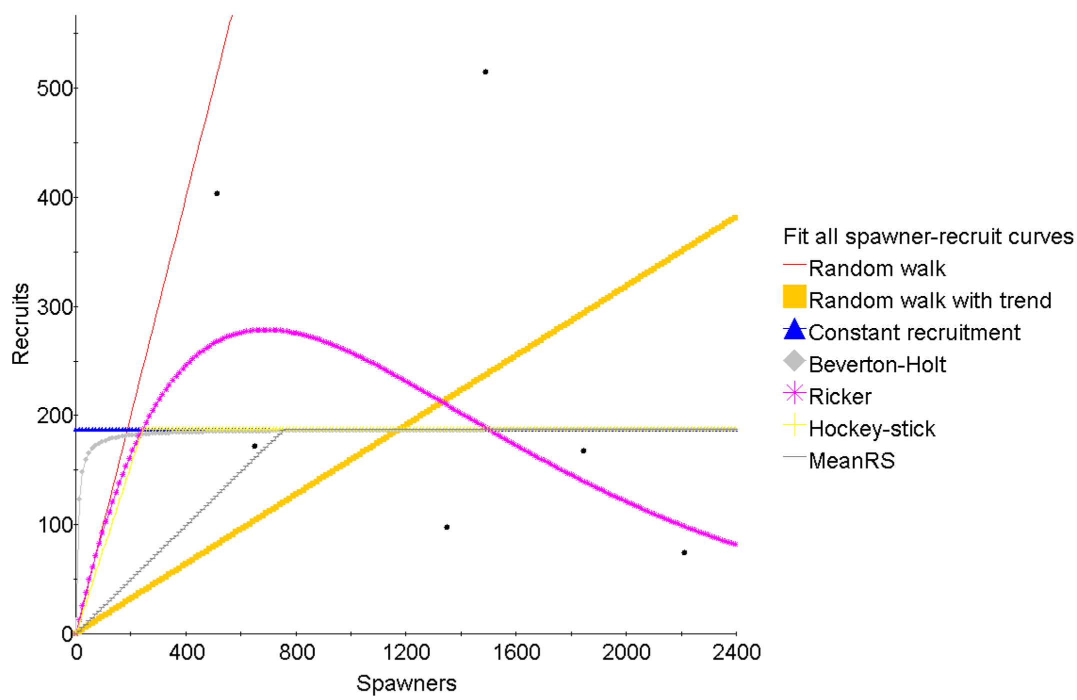

Figure 25: Hood River Summer Steelhead escapement recruitment functions.

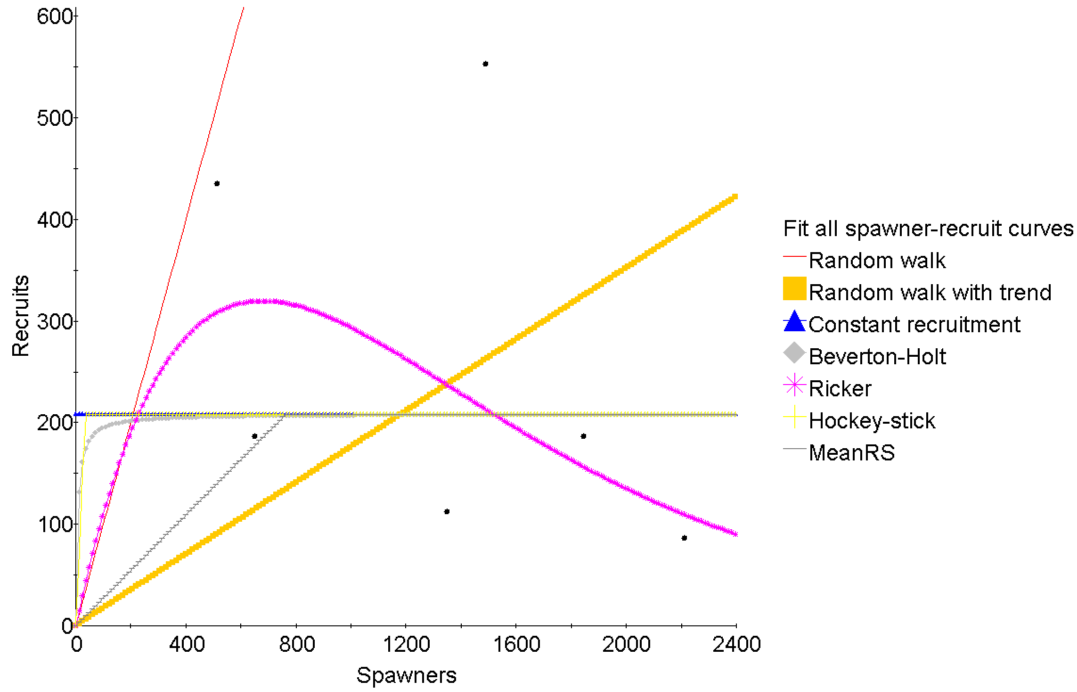

Figure 26: Hood River Summer Steelhead preharvest recruitment functions.

Table 12: Hood River Summer Steelhead summary statistics

Statistic	Escapement	Preharvest
Time Series Period	1993 - 2005	1993 - 2005
Length of Time Series	13	13
Geometric Mean Natural Origin Spawner Abundance	195 (135 - 283)	NA
Geometric Mean Recruit Abundance	188 (84 - 419)	208 (96 - 450)
Lambda	0.811 (0.046 - 14.325)	0.821 (0.049 - 13.745)
Trend in Log Abundance	0.995 (0.898 - 1.104)	0.995 (0.898 - 1.104)
Geometric Mean Recruits per Spawner (all broods)	NA	NA
Geometric Mean Recruits per Spawner (broods < median spawner abundance)	NA	0.528
Average Hatchery Fraction	NA	0.114
Average Harvest Rate	NA	NA

Table 13: Escapement recruitment parameter estimates and relative AIC values for Hood summer steelhead. The 95% probability intervals on parameters are shown in parentheses. The model that is the "best" approximation (i.e., relative AIC = 0) is shown in bright green. Models that nearly indistinguishable from best (i.e., relative AIC <2) are shown in darker green. Models that are possible, but less likely, contenders as best (i.e., 2 < relative AIC < 10) are shown in yellow. Models that are very unlikely to be the best approximating model (i.e., relative AIC > 10) are not highlighted (i.e., white background).

Model	Productivity	Capacity	Variance	Relative AIC
Random walk	NA	NA	2.13 (1.49-2.89)	11.4
Random walk with trend	0.16 (0.12-0.95)	NA	1.06 (0.86-2.62)	5.1
Constant recruitment	NA	187 (116-594)	0.7 (0.56-2.08)	0
Beverton-Holt	>30 (1.15->30)	188 (117-762)	0.7 (0.57-2.05)	2
Ricker	1.1 (0.25-23.71)	279 (249-3564)	0.59 (0.6-2.47)	0
Hockey-stick	0.77 (1.19->30)	188 (116-683)	0.7 (0.56-2.02)	2
MeanRS	0.25 (0.11-0.55)	188 (118-300)	0.72 (0.13-1.03)	3.5

Table 14: Preharvest recruitment parameter estimates and relative AIC values for Hood summer steelhead. The 95% probability intervals on parameters are shown in parentheses. The model that is the "best" approximation (i.e., relative AIC = 0) is shown in bright green. Models that nearly indistinguishable from best (i.e., relative AIC <2) are shown in darker green. Models that are possible, but less likely, contenders as best (i.e., 2 < relative AIC < 10) are shown in yellow. Models that are very unlikely to be the best approximating model (i.e., relative AIC > 10) are not highlighted (i.e., white background).

Model	Productivity	Capacity	Variance	Relative AIC
Random walk	NA	NA	2.02 (1.43-2.87)	11.3
Random walk with trend	0.18 (0.12-1)	NA	1.03 (0.83-2.58)	5.2
Constant recruitment	NA	209 (130-603)	0.67 (0.53-1.96)	0
Beverton-Holt	>30 (1.1->30)	209 (133-832)	0.67 (0.54-2)	2
Ricker	1.28 (0.26-23.3)	320 (255-4475)	0.57 (0.56-2.47)	0.1
Hockey-stick	6.2 (0.87->30)	208 (131-942)	0.67 (0.54-2.03)	2
MeanRS	0.27 (0.13-0.59)	208 (134-327)	0.67 (0.12-0.95)	3.6

A&P - Criterion *Summary*

For the abundance and productivity criterion, the most probable risk category for all but two of these populations is high (Figure 27). The exceptions are most probable classifications of 'moderate risk' for the Hood winter-run population and 'low risk' for the Clackamas population. Although the shape of the diamonds in Figure 27 suggest there is considerable uncertainty as to the status classification of these two populations. From the perspective of this viability criterion LCR steelhead in Oregon are clearly at high risk.

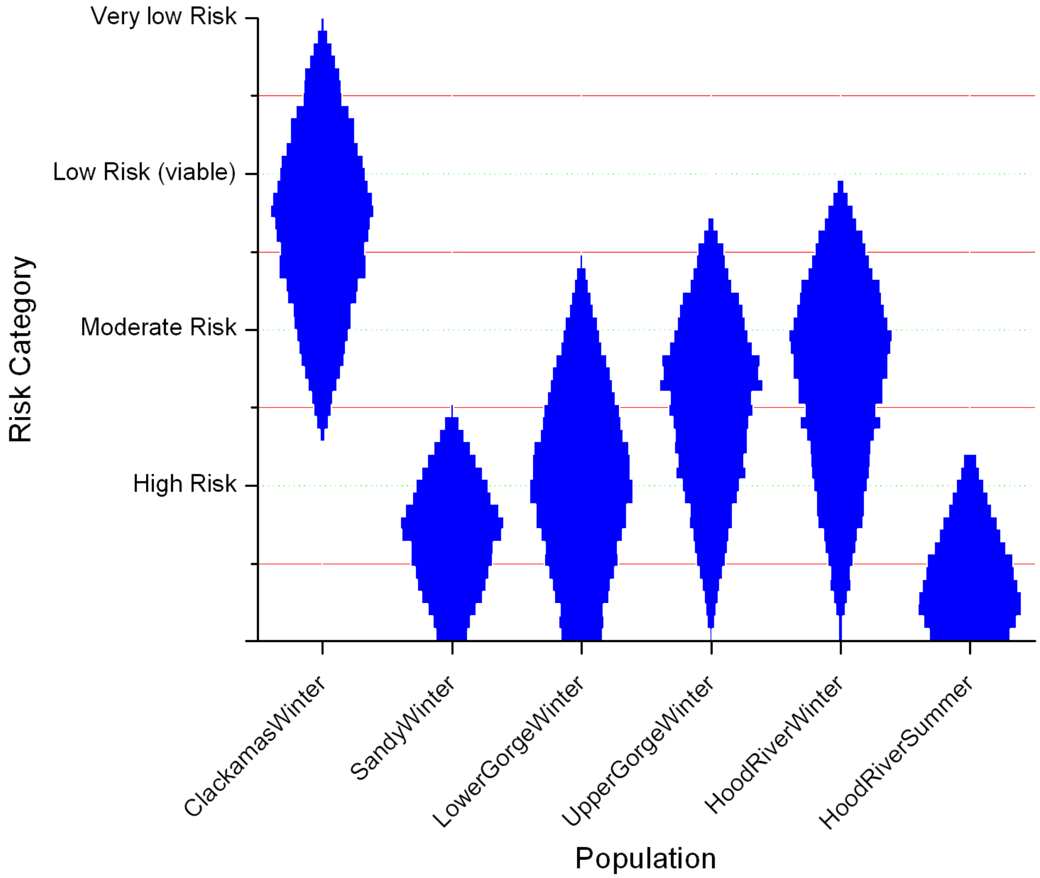

Figure 27: LCR steelhead risk status summary based on evaluation of abundance and productivity only.

III. Spatial Structure

SS - Clackamas

Virtually all of the habitat accessible to winter steelhead in the Clackamas River remains accessible today (Figure 28) (ODFW 2005). Losses of accessibility are limited to higher order tributary streams, primarily due to watershed development in the lower basin. The upper Clackamas basin contains most of the historically-productive habitat for steelhead and most of that habitat is of high quality today. Spatial structure has likely been reduced by habitat degradation in lower basin tributaries. The watershed score was reduced to address a likely loss in spatial diversity related to habitat degradation in the low elevation streams. Habitat declines in the Willamette and Columbia mainstem and estuary were not factored into steelhead spatial structure scores because these habitats are much less important to the life history of lower Columbia River winter steelhead than for species.

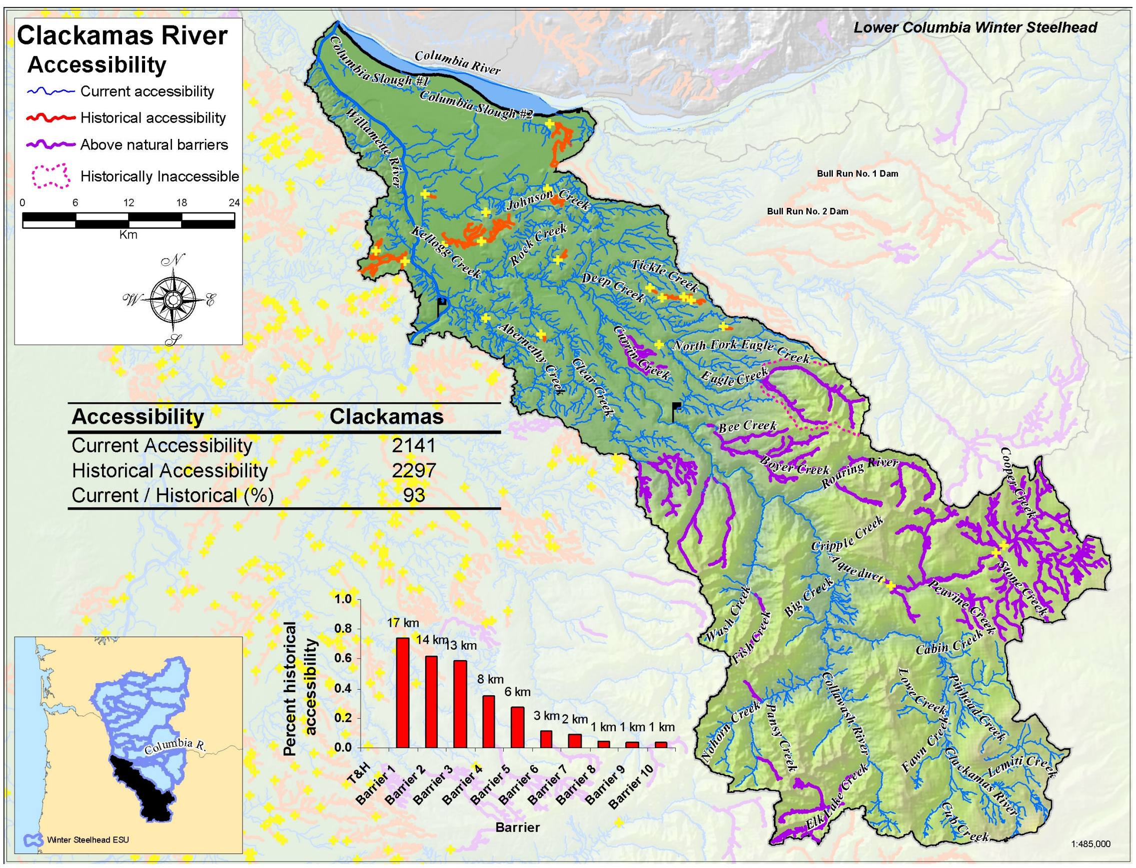

Figure 28: Clackamas River winter steelhead current and historical accessibility (updated by Sheer 2007 from Maher et al. 2005). As described in the Introduction (Part 1), these maps depict *access* (i.e. where fish could swim) and not necessarily habitat that fish would use.

SS - Sandy

Significant portions of the historical winter steelhead in the Sandy River have been blocked by dam construction in the Bull Run and Little Sandy watersheds (Figure 29)(ODFW 2005). Blocked areas were productive habitats for steelhead. Large areas of productive high quality habitat remain accessible to steelhead in the remainder of the basin, particularly in the forested upper basin. A distribution adjustment was warranted because the remaining habitat is largely concentrated in watersheds directly fed by Mt Hood. No further modification is warranted because of the remaining wide distribution of productive steelhead habitats. Habitat declines in the estuary were not factored into steelhead spatial structure scores.

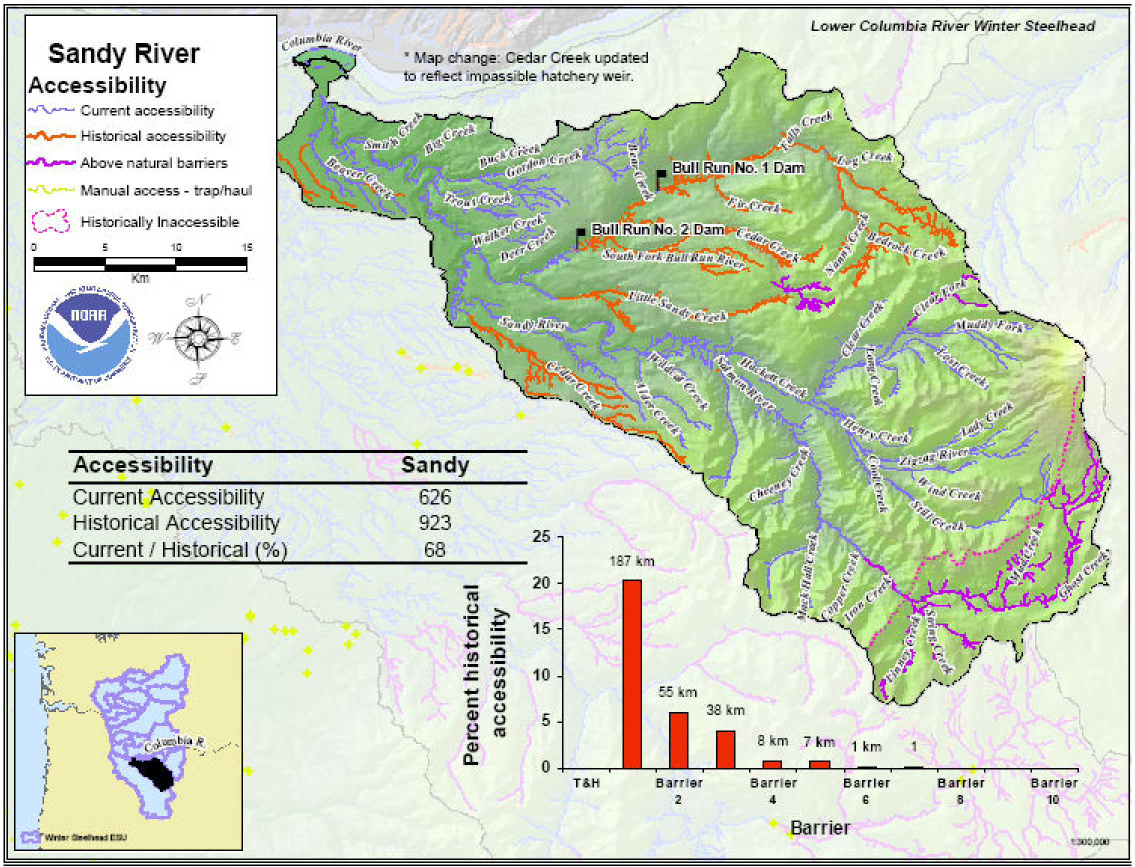

Figure 29: Sandy River winter steelhead current and historical accessibility (updated by Sheer 2007 from Maher et al. 2005). As described in the Introduction (Part 1), these maps depict *access* (i.e. where fish could swim) and not necessarily habitat that fish would use.

SS - Lower Gorge Tributaries

Most of the small Columbia River gorge streams between the Sandy River and Eagle Creek remain largely accessible to steelhead (Figure 30)(ODFW 2005). Habitat availability is limited to the lower portions of these streams by topography. A hatchery weir blocks small sections of Tanner and Eagle Creek but this is a significant percentage of the historical habitat in this small lower gorge watershed. A further modification is warranted by habitat alternations and development which has likely reduced local habitat quality in some streams.

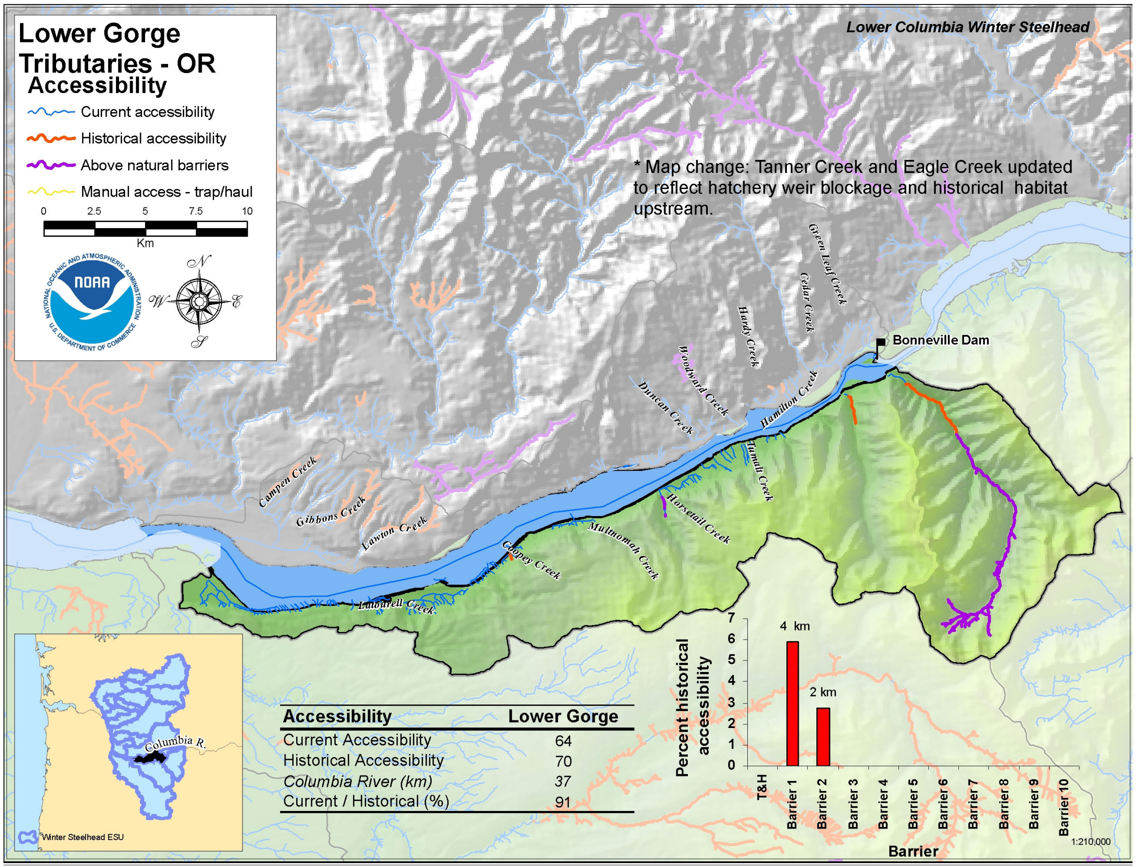

Figure 30: Lower gorge winter steelhead current and historical accessibility (updated by Sheer 2007 from Maher et al. 2005). As described in the Introduction (Part 1), these maps depict *access* (i.e. where fish could swim) and not necessarily habitat that fish would use.

SS - Upper Gorge Tributaries

The small Columbia River gorge streams upstream from Eagle Creek remains largely accessible to steelhead (Figure 31). The amount of habitat is limited to the lower portions of these streams by topography and portions of the lower reaches have been inundated by the Bonneville Dam reservoir. Other local habitat alternations and development have likely reduced habitat quality in some streams.

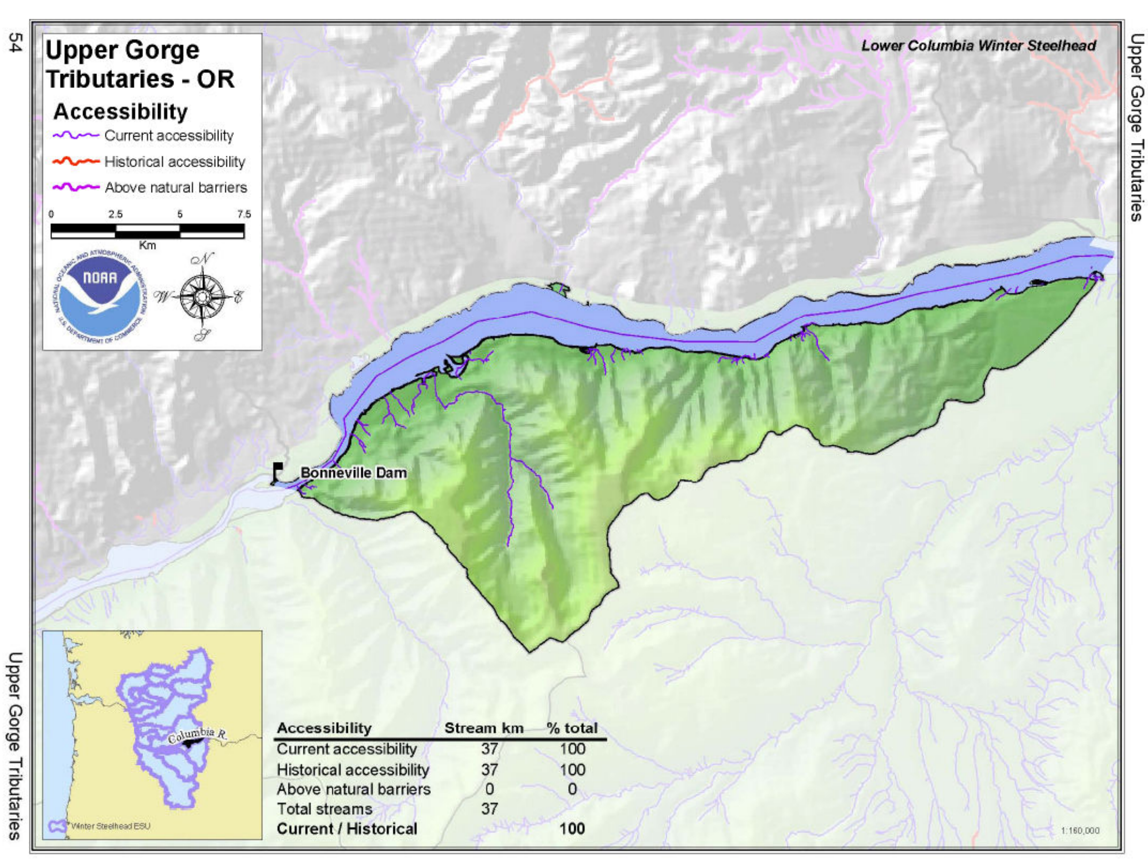

Figure 31: Upper gorge winter steelhead current and historical accessibility (updated by Sheer 2007 from Maher et al. 2005). As described in the Introduction (Part 1), these maps depict *access* (i.e. where fish could swim) and not necessarily habitat that fish would use.

SS - Hood River

Virtually the entire habitat accessible to winter steelhead in the Hood River remains accessible today (Figure 32)(ODFW 2005). Blockages are limited to only a few headwater reaches and these streams do not represent significant historical steelhead production areas. Declines in habitat quality in lower elevations streams of the basin have likely reduced the spatial structure of steelhead production in the basin.

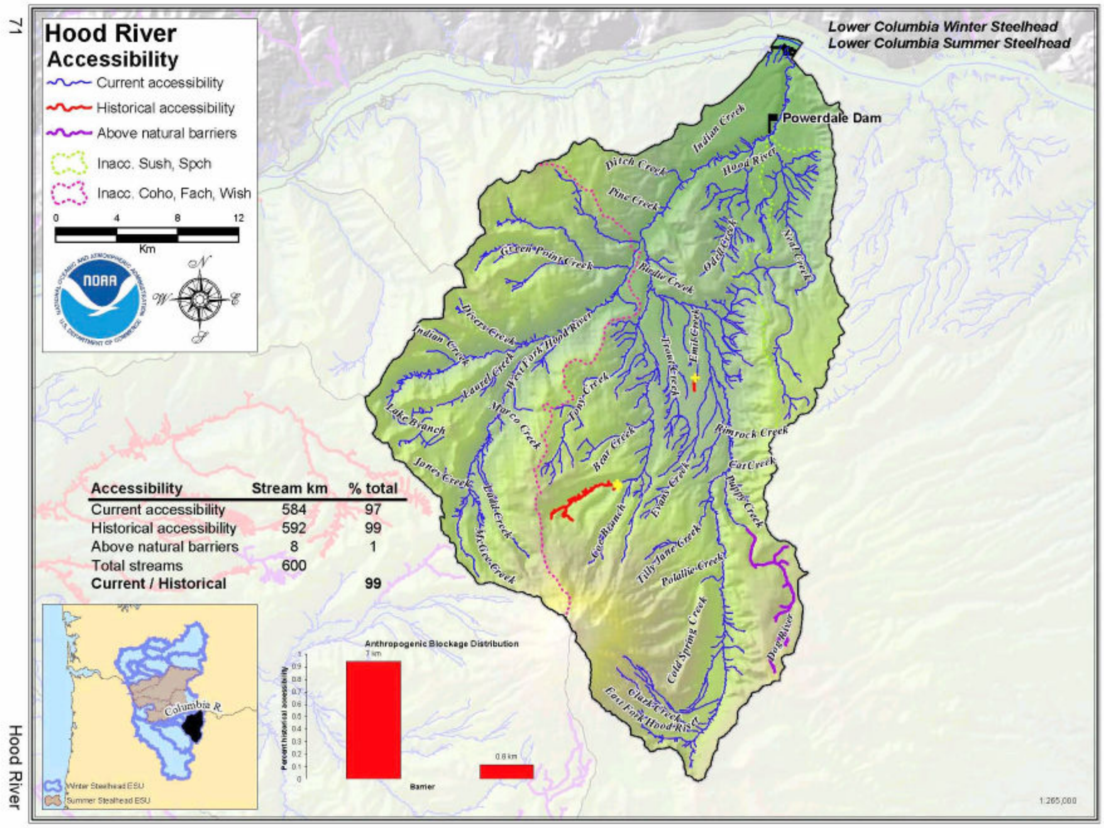

Figure 32: Hood River winter and summer steelhead current and historical accessibility (updated by Sheer 2007 from Maher et al. 2005). As described in the Introduction (Part 1), these maps depict *access* (i.e. where fish could swim) and not necessarily habitat that fish would use.

SS - Hood River – summer

Nearly all historical habitat remains accessible to summer steelhead although significant production areas are largely limited to the West Fork (Figure 32). However, the limited distribution of summer steelhead in the basin warrants a downward adjustment to the spatial score.

SS – Criterion Summary

Steelhead in the Sandy basin have experienced more than a 30% loss of the habitat historically accessible to steelhead due to anthropogenic blockages, primarily dams on the Bull Run River (Figure 33). For the remainder of the populations the less than 5% of the historically accessible habitat has been lost. SS scores for each population were adjusted, where applicable, on the basis of two factors: 1) the suitability/quality of the blocked habitat with respect to steelhead production and 2) the degree to which the remaining accessible habitat has been degraded from historical conditions. The adjustments and final SS scores for each population are presented in Table 15.

For the SS criterion the most probable risk category for a majority of the populations was 'low' as evidenced by the SS rating in Table 15 and illustrated by the placement of the widest portion of the diamonds in Figure 34- the Sandy population, with a most probable rating of "moderate risk" being the exception. However, these diamonds also show that there is a substantial level of uncertainty associated with the scoring. For example, as illustrated by the placement of the lower portion of the diamond symbols it is possible (but not probable) that all of the populations could fall into the 'low risk' category (Figure 37). However, the most probable call on the overall picture for LCR steelhead in Oregon with respect to this criterion would be the 'low risk' category.

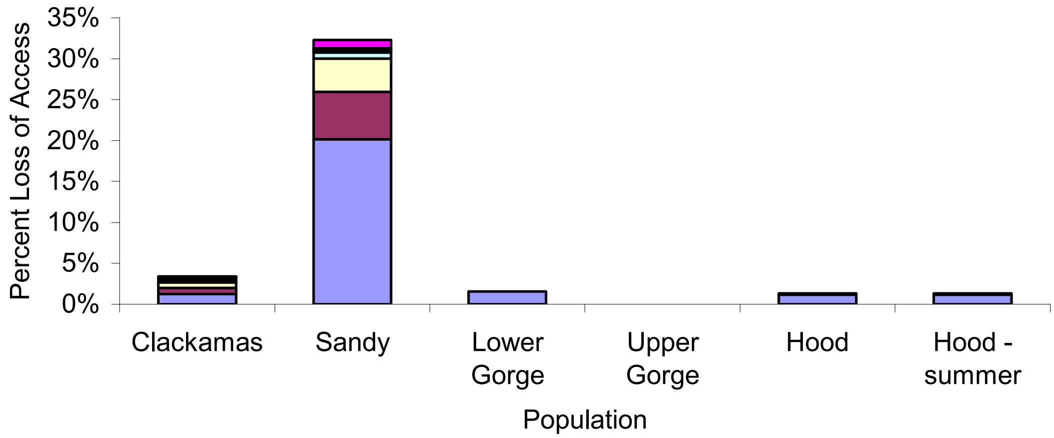

Figure 33: Percent loss in LCR winter and summer steelhead accessibility due to anthropogenic blockages (based on Maher et al. 2005 except as noted). Each color represents a blockage ordered from largest to smallest (bottom-up). The topmost blockages, for example the pink segment of the Sandy bar, is a collection of many smaller blockages. Note that the pool of smaller blockages can be greater than larger single blockages. These percentage estimates are based on most recent (2007) barrier information that differs from the Maher et al. Figures as described in the accessibility map figure legends.

Table 15: Spatial structure scores for LCR steelhead.

Population	Base Access Score	Adjustment for Large Single Blockage	Adjusted Access Score	SS Rating Considering: Access Score, Historical Use Distribution, and Habitat Degradation	Confidence in SS rating
Clackamas	4	N	4	3	M
Sandy	2	Y	1.5	1.5	M
Lower Gorge Tributaries	4	N	4	3	L
Upper Gorge Tributaries	4	N	4	3	L
Hood River	4	N	4	3	M
Hood River – summer	4	N	4	3	L

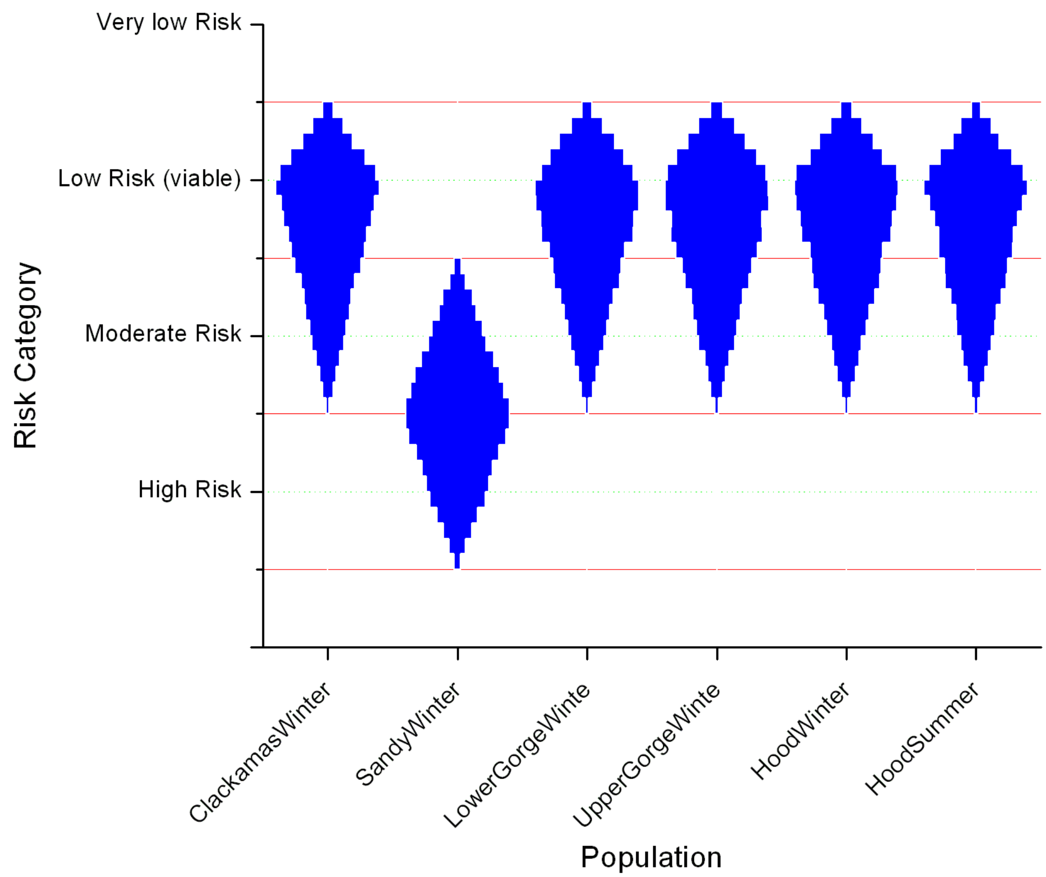

Figure 34: LCR steelhead risk status summary based on evaluation of spatial structure only.

IV. Diversity

DV - Background and Overview

Two major life history types of steelhead were historically, and are presently, found in the Lower Columbia River: the summer run and winter run. The life histories of summer- and winter-run steelhead have considerable overlap. Both rear in freshwater for 1 to 4 years prior to smoltification, select similar habitats for freshwater rearing, and spend 1 to 4 years in the ocean. However, substantial differences separate these races at the time of adult freshwater entry, degree of sexual maturity at entry, spawning time, and frequency of repeat spawning.

In the Lower Columbia River, most wild steelhead are 4 to 6 years of age at first spawning, 50 to 91 cm in length, and 2 to 8 kg in weight. However, they can attain ages of 9 years old and reach lengths of over 100 cm (12 kg) (Busby et al. 1996). Steelhead may spawn more than once, although the frequency of repeat spawners is currently relatively low (<10%). At least 9 different initial and 13 different repeat age classes have been identified for Lower Columbia River steelhead (Leider et al. 1986).

Each year, the majority of naturally produced Lower Columbia River summer steelhead return to freshwater primarily between May and October. These fish are sexually immature upon return to their natal streams. The fish subsequently spawn between January and June, with peak spawning between late February and early April (Leider et al. 1986, WDFW unpublished data). The repeat spawner rate is about 5.9% for wild summer steelhead (Hulett et al. 1993). In contrast, wild winter steelhead enter freshwater as sexually mature fish between December and May. Spawning occurs between February and June, with peak spawning time in late April and early May, almost two months later than wild summer steelhead (Leider et al. 1986 and WDFW unpublished data). The repeat spawner rate for wild winter steelhead is 8.1% on the Kalama River; double that of wild summer steelhead (Hulett et al. 1993).

On average, there is a 2-month difference in peak spawning time between winter- and summer-run steelhead, although there is probably certainly some temporal overlap in the spawning distribution (Busby et al. 1996). Within the same watershed winter and summer steelhead maintain a high degree of reproductive isolation by spawning in geographically distinct areas. Hatchery introductions, especially with non-native steelhead, and modifications to barrier falls are a potential source for the breaking down of historical reproductive barriers and the erosion of locally adapted genotypes.

The tendency for summer-run steelhead to return to specific areas above barrier falls may require a higher level of homing fidelity than exhibited by Chinook salmon or winter-run steelhead. This fidelity may have important consequences in the rate of development or specificity of locally-adapted traits.

Phelps et al. (1997) examined the relationship between coastal summer and winter steelhead populations. In their genetic analysis, the summer and winter runs within the genetic diversity units (GDUs) were more closely related to each other than to collections from other GDUs, indicating that the run-timing characteristics evolved from a single evolutionary source within each basin. A similar relationship has been observed between spring and fall-run Chinook salmon in coastal watersheds in Washington, Oregon, and California, including the Lower Columbia River (Myers et al. 1998). This relationship provides a framework for evaluating the genetic effects of hatchery transfers on target populations.

DV – Clackamas River Winter Run

Life History Traits – Abernethy (1886) reported that steelhead entered the river from December 1st to February 15th. Currently, Clackamas River winter steelhead enter the river from February through May and spawn from May to June (Murtagh et al. 1992). Olsen et al. (1992) reported that prior to the introduction of early-winter (Big Creek) steelhead, passage at North Fork Dam peaked in May. The majority of steelhead return at 4 years of age, with a repeat spawning incidence of 11% (Chilcote 2001). The apparent change in run timing, may be due to a number of factors – further investigation is needed. Score = NA

Effective Population Size - In recent years the abundance of returning adults to North Fork Dam has been several hundred to a few thousand, although the long-term average is approximately 450. Score = 3.0

Hatchery Impacts

Hatchery Domestication – There are three hatchery stocks of steelhead released into the Clackamas River, early-winter (introduced), late-winter (native), and summer run (introduced). Since 1999, only unmarked steelhead have been allowed above North Fork Dam, although prior to that the hatchery contribution was about 25% of the run. The ODFW Clackamas Hatchery currently rears a winter run broodstock (122W) developed from unmarked fish at North Fork Dam. In 2003, 18 females and 32 males were spawned (including 25 unmarked fish) at the Clackamas Hatchery for the "wild" broodstock. Score = NA.

Hatchery Introgression – There are a number of hatchery programs that release steelhead into the Clackamas River Basin; however only the Clackamas Hatchery winter steelhead (#122) derived from late returning "native" spawners is considered part of the ESU (SHAGG 2003). The Big Creek Hatchery stock of winter steelhead return to the Clackamas River earlier, October to early March, than the native winter steelhead, February to June (Murtagh et al. 1992). Furthermore, the peak spawning period for Big Creek derived fish is January to early March compared with May and June for native Clackamas River winter steelhead
The introduction of early-winter and summer steelhead from outside of the basin may have influenced the diversity of the native late-winter run, although differences in run timing probably limit the degree of introgression. Chilcote (2001) estimated that competition between summer and winter-run steelhead probably reduced the productivity of the winter run population, but it is not know if there has been any effect on life history diversity. Score = 2-3.

Synthetic Approach – The situation in the Clackamas River is somewhat complex given that two (Skamania-derived summer run and Big Creek-derived winter run) of the three runs of steelhead released into the basin are not native. The locally-derived late-winter steelhead hatchery broodstock program is relatively small. Currently, hatchery fish are removed at North Fork Dam, although prior to 2002 summer run fish were released into the Upper Clackamas River. The proportion of hatchery-origin fish is on the spawning grounds (lower river only) is presently 25%, although in past years it has been much higher ($0.10<Ph<0.30$). On average the genetic similarity between hatchery- and naturally-produced is very low. Diversity persistence score = 1.0 – 2.0.

Anthropogenic Mortality – Harvest rates on "unmarked" winter steelhead are thought to be relatively low (<5.0%). From 1917 to 1939, passage at Faraday Dam (North Fork Dam) was blocked after the fish ladder washed out in a flood, prior to this, passage was somewhat restricted. After 1939, much of the watershed was naturally recolonized by steelhead. It is not know how habitat degradation in the lower Clackamas River and lower mainstem Willamette River and its tributaries (Kellogg and Johnson Creeks) may have influenced life history characters. Score =2-3.

Habitat Diversity – Although the quality of habitat may be severely degraded the proportion of there has been little change in the size distribution of the Clackamas and its tributaries. There has been a marked loss in the elevation complexity of the basin. Score = 2/4

***Overall Score* = 2.5.** There may have been a change in life history characters with the blocked passage at Faraday Dam for 20 years. Effective population size is moderate, with several low abundance years.Previously: 2004 TRT 1.58; 2004 ODFW pass, all criteria meet

DV – Sandy River Winter-Run Steelhead

Life History Traits – Winter and summer steelhead are present in the Sandy River Basin, although only winter steelhead are thought to be native (Kostow 1995). Steelhead spawning operations on the Salmon River, a Sandy River tributary, collected eggs from March 20th to May 27th, 1901 (ODF 1903), a spawn timing similar to present-day native steelhead in the Sandy River, March to early May (Olsen et al. 1992). Current age structure, 63% 4-year old and 23 % 5 year old spawners, does not appear to be divergent form other populations in this stratum (Chilcote 2001). Little available information, no known changes.
Score = NA.

Effective Population Size **-** Historically, winter steelhead escapement may have been in excess of 20,000 fish (Mattson 1955). Loss of spawning habitat in the Bull Run and Little Sandy River Basins in combination with the effects of dams on the mainstem Sandy River reduced the run to 4,400 in 1954. More recently, the estimated "wild" escapement of hatchery fish over Marmot Dam (RKm 43) was 851 in 1997, although there was considerable difficulty in distinguishing between wild and hatchery derived winter steelhead (Chilcote 1997)..
Score = 2-3.

Hatchery Impacts

Hatchery Domestication – Winter steelhead have been propagated in the Sandy River Basin since 1900 (Wallis 1963). There have been three winter steelhead stocks released in the Sandy. Initially, returning adults were intercepted for use as broodstock. Beginning in 1960, Big Creek winter steelhead were introduced into the Sandy River (Wallis 1963). Recently, there has been a phase out from the release of the Big Creek stock (ODFW#013) in favor of the locally derived Sandy River broodstock (ODFW#011W). In 2003, 81 unmarked fish were collected at the Marmot trap (approximately 50% spawners used for the wild broodstock). Hatchery fish constituted nearly 40% of the winter steelhead passing over Marmot Dam in 1997 (Chilcote 1997). However, the frequency of hatchery fish arriving at Marmot Dam has also declined in recent years. In addition, the removal of all marked (hatchery) fish at the Marmot Trap beginning in 1999 prevented hatchery-origin fish from accessing the primary steelhead production areas upstream of the dam. Therefore, the percentage of hatchery fish spawning upstream of Marmot dam since 1999, has effectively been zero (see Appendix B).Releases of summer steelhead (Skamania Hatchery stock) began in 1976, and spawning escapement to Sandy River currently averages 2,000 fish (Chilcote 1997). Additionally, there are plans to remove several dams on the Bull Run that may provide additional spawning and rearing habitat to a tributary that once produced significant numbers of steelhead (Mattson 1955). *PNI ≤ 1.00 (current) 6 years, 0.25 (historical) 80 years, Fitness = 0.60.* Score = 1.5.

Hatchery Introgression – For a number of years, non-local Big Creek steelhead and Skamania summer steelhead have been released in to the Sandy River. Big Creek releases have been terminated, but still continue for Skamania Hatchery Fish. Due to differences in spawn timing it is not know to what extent the early-winter and summer runs have interbreed with the local population. Competition effects are likely to continue between released summer run and local winter run juveniles. Score = NA

Synthetic Approach – The hatchery situation in the Sandy River is currently in a transitional state. The release of early-winter run steelhead (Big Creek Hatchery) has recently been terminated in preference to a locally-derived late winter run. In addition, summer-run steelhead (Skamania Hatchery) have been released into the basin since 1976. Hatchery (marked) steelhead have been removed at the Marmot Dam trap since 1999. There is likely little steelhead spawning in the lower portion of the river (below Marmot Dam); therefore the effective stray rate is near 0. (Ph <0.05). Naturally-spawning hatchery fish would include both out-of-ESU summer run fish (potentially including feral summer run fish) and locally-derived winter run fish with an overall low genetic similarity between hatchery and wild populations. In consideration of the duration of past hatchery releases throughout the basin the score was reduced by 1. Diversity persistence score = 4.0 – 1.0 = 3.0.

Anthropogenic Mortality – Prior to 1991, harvest rates for Sandy River winter steelhead averaged 40%, but with the initiation of selective fisheries this rate dropped to 4% for unmarked fish (Chilcote 2001). Changes in mainstem and estuary habitat may have had an influence on life history diversity – although it is not possible to quantify this effect.
Score = NA**.**

Habitat Diversity – Although the quality of habitat may be severely degraded the proportion of accessible stream size reflects historical conditions, while much of the elevation diversity has been lost.
Score *(Order/Elevation)* = 2/3.

Overall Score = 2.0. The long-term effects of the steelhead hatchery program may have had a considerable influence on diversity. Additionally, there are a number of effects (i.e., habitat degradation and harvest) that may have influenced diversity but the information on these processes is limited. Previously: 2004 TRT 1.56; 2004 ODFW fail, 4-5 criteria met.

DV – Lower and Upper Gorge[1] Tributaries Winter-Run Steelhead

[1] In light of the paucity of information on these two DIPs, the evaluations have been combined. As more specific information becomes available, it will be useful to evaluate these DIPs independently.

Life History Traits – The only information available is from the Washington side of the DIP, Hamilton Creek and Wind River winter run steelhead. River entry begins in December and extends to early May, with spawning occurring from March to early June (SaSI 2003). There is no historical information on steelhead from either side of the Columbia River.
Score = NA.

Effective Population Size **-** Information on the escapement to these DIPs is largely unknown. Some survey work has been undertaken, but on an inconsistent basis. In general, escapement in each of the DIP likely numbers in the tens or low hundreds of fish.
Score = 1-2.

Hatchery Impacts

Hatchery Domestication – There have been a number of hatchery releases into these DIPs, although the persistence of these releases is unknown. Although no estimate could be generated, the effect is thought to be significant.
Score = NA.

Hatchery Introgression – There is little information on out-of-stratum or out-of-ESU introductions or strays. While large numbers of summer steelhead migrate through these DIPs bound for the Mid and Upper Columbia River and Snake Rivers it is unlikely that any would stray into the small tributaries along the Oregon side of these DIPs.
Score = NA.

Lower Gorge

Synthetic Approach – There is very little available information on the influence of hatchery-origin fish on spawning aggregations within this population. Historically there have been a number of releases from various hatcheries, but there are currently no winter run being released. Large numbers of predominately summer run steelhead migrate past the small tributaries on the Oregon side of this DIP, but it is unlikely that they would be diverted into these small systems. While the number of hatchery fish naturally spawning may be low, the overall abundance in this DIP is also probably low. As a percentage hatchery fish may be significant (Ph>0.10) and the genetic similarity low to very low. Diversity persistence score = 2.0 or 3.0.

Upper Gorge

Synthetic Approach – There is very little available information on the influence of hatchery-origin fish on spawning aggregations within this population. Historically there have been a number of releases from various hatcheries, but there are currently no winter run being released from the Oregon side of this DIP (although on the Washington side, there are large releases into the Wind River. Large numbers of predominately summer run steelhead migrate past the small tributaries on the Oregon side of this DIP, but it is unlikely that they would be diverted into these small systems. ODFW suggests that this DIP may be similar to the Hood River winter run DIP. While the number of hatchery fish naturally spawning may be low, the overall abundance in this DIP is also probably low. As a percentage hatchery fish may be significant (Ph>0.10) and the genetic similarity low to very low. Diversity persistence score = 2.0 or 3.0.

Anthropogenic Mortality – Prior to 1991, harvest rates winter steelhead were about 20%, but with the initiation of selective fisheries this rate should have dropped to 4% or less for unmarked fish (Chilcote 2001). Harvest and habitat effects are likely, but have not been quantified. Spring run net fisheries may have incidentally captured returning winter steelhead, potentially at a high rate.
Score =**.**

Habitat Diversity – Habitat diversity estimates were not made for these DIPs.
Score *(Order/Elevation)* = NA

***Overall Score* = 1.5 .** Low effective population size and the effects of the hydro-operation have likely influenced these DIPs. Additionally habitat degradation instream and in the migratory/rearing corridors may also have influenced life history diversity. Previously: 2004 TRT 0.94 (LG) and 0.86 (UG); 2004 ODFW pass, all criteria met.

DV – Hood River Winter Run

Life History Traits – Based on observed run timing at Powerdale Dam, the "native" winter steelhead return from March to late June (Olsen et al. 1994). Chilcote (2001) estimated that 60% of the fish returned at Age 4 and 25% at Age 5.
Score = NA.

Effective Population Size **-** Escapement has ranged from a few hundred to nearly a thousand fish with varying levels of hatchery fish contributing to escapement (Goodson 2005)..
Score = 2-3.

Hatchery Impacts

Hatchery Domestication – Hatchery winter steelhead (ODFW Big Creek Hatchery #13) were released into the Hood River Basin since 1962. Genetic analysis by Schreck et al. (1986) indicated that the Hood River Hatchery broodstock was similar to Eagle Creek NFH broodstock (Big Creek influenced). The program was terminated following the development of a local winter steelhead broodstock (ODFW #50W) in 1991. The winter steelhead #50W broodstock was established using unmarked returning steelhead, although it is possible that some naturally produced Big Creek origin fish were incorporated (as well as unmarked fish from other basins or hatcheries). Hatchery broodstock have been derived from a mix of returning marked fish and unmarked fish captured from the river – unmarked fish have contributed from 50 – 100% of broodstock in any given year. Genetically, the present-day Hood River and Big Creek winter steelhead are quite distinct from one another (Kostow et al. 2000). It is not known to what extent non-native hatchery introductions and habitat degradation have altered life history trait expression. For 2000-2004, the average contribution of hatchery fish to natural escapement was 39% (Goodson 2005). PNI ≤ 0.6, Fitness > 0.90**.** Score = 3-4.

Hatchery Introgression – The introduction of Big Creek winter steelhead may have resulted in the loss of local adaptation. Recent genetic analysis suggests that the legacy of these introductions has been minimal. Score = NA.

Synthetic Approach – Both winter and summer run steelhead are released into the Hood River Basin. In 1991 a locally derived winter run hatchery broodstock was developed for the Hood River, prior to that Big Creek Hatchery early-winter run steelhead were released. Recent information from fish passed over Powerdale Dam in the lower Hood River suggest nearly 50% of the run is of hatchery origin (0.75>Ph>0.30). Approximately half of the broodstock used in the hatchery are naturally produced. Diversity persistence score = 1.0 - 2.0.

Anthropogenic Mortality – Chilcote (2001) estimated that the average harvest rate from 1995-2000 for unmarked "wild" fish was approximately 14%. Changes in river conditions in the Hood River Basin and in the migratory and rearing corridors in the mainstem and estuary may also have affected life history diversity, but to an unknown extent.
Score = NA**.**

Habitat Diversity – Although the quality of habitat may be severely degraded the proportion and character (elevation and stream size) of accessible habitat reflects historical conditions.
Score *(Order/Elevation)* = 1/4

***Overall Score* = 2.5 .** Effective population size was a primary concern; however, hatchery effects and habitat degradation are largely unknown but probably significant factors.
Previously: 2004 TRT 1.81; 2004 ODFW pass, all criteria met.

DV – Hood River Summer-Run Steelhead

Life History Traits – Steelhead enter the river from May to early November (Olsen et al. 1994). Chilcote (2001) estimated that 56% of the run consists of Age 4 fish, and 29% of Age 5 fish.
Score = NA.

Effective Population Size **-** Native summer steelhead escapement was 181 in 1997, and may have been as low as 80 in 1998 (Chilcote 1997). Since that time abundance has averaged a few hundred fish, 293 for 2000 to 2004 (Goodson 2005)..
Score = 2.

Hatchery Impacts

Hatchery Domestication – A local summer steelhead broodstock (ODFW #50W) was established in 1998, using unmarked returning summer steelhead. Skamania Hatchery derived summer steelhead (ODFW #24) have been released in the basin for a number of years, and it is possible that unmarked (naturally produced) Skamania summer steelhead were incorporated into the broodstock (Kostow et al. 2000). From 1993 to 1998, unmarked summer steelhead accounted for only 16.1% of the summer steelhead passed over Powerdale Dam (Goodson 2005). Beginning in 1997, however, releases in the upper basin were terminated and marked summer steelhead are prevented from migrating past Powerdale Dam (Rkm 6.4). With the development of a locally-base broodstock, the percentage of hatchery-origin fish allowed past Powerdale Dam has increased to 58% of escapement in 2004. Unmarked fish are used as broodstock for the current hatchery program (50W). There is no genetic analysis available for Hood River summer steelhead. *PNI ≤ 0.85, Fitness > 0.90*. Score = 3-4.

Hatchery Introgression – It is unclear to what extent previous releases of Skamania Hatchery summer steelhead may have influenced the genetic and phenotypic diversity of the local population. Future genetic studies may provide some insight into this effect. Score = NA.

Synthetic Approach – Both winter and summer run steelhead are released into the Hood River Basin. In 1998 a locally derived summer run hatchery broodstock was developed for the Hood River, prior to that Skamania Hatchery summer run steelhead were released. Recent information from fish passed over Powerdale Dam in the lower Hood River suggest nearly 50% of the run is of hatchery origin (0.75>Ph>0.30). Currently, unmarked fish are used as broodstock – high to moderate. Diversity persistence score = 2.0 – 3.0.

Anthropogenic Mortality – Chilcote (2001) estimated that the average harvest rate from 1995-2000 for unmarked "wild" fish was approximately 10%. Changes in river conditions in the Hood River Basin and in the migratory and rearing corridors in the mainstem and estuary may also have affected life history diversity, but to an unknown extent.
Score = **3-4.**

Habitat Diversity – Although the quality of habitat may be severely degraded the proportion and character (elevation and stream size) of accessible habitat reflects historical conditions.
Score *(Order/Elevation)* = 3/4.

***Overall Score* = 2.0.** Of the factors that could be evaluated, effective population size had the strongest downward effect on diversity. Past hatchery introductions and habitat degradation effects were also thought to be significant, but could not be evaluated.. Previously: 2004 TRT 1.26; 2004 ODFW fail, 4-5 criteria met.

DV – Criterion Summary

With the exception of the gorge populations, there is empirical evidence that all of the historical populations in Oregon's portion of this DIP are extant. Loss of genetic resources due to small population size during the 1990s and high incidence of hatchery strays are the primary reasons that the majority of the populations had a most probable risk classification 'moderate' or 'high' (Figure 35). Only the winter steelhead populations in the Clackamas and Hood basins met the viable threshold, and just barely so. Because of the uncertainty associated with the population ratings for the DV criterion, the possibility exists that three of the six populations fall into the 'high risk' category, as illustrated by the placement of the lower portion of the diamonds in Figure 38. However, overall we believe the most probable DV risk classification for Oregon's LCR steelhead populations is 'moderate'.

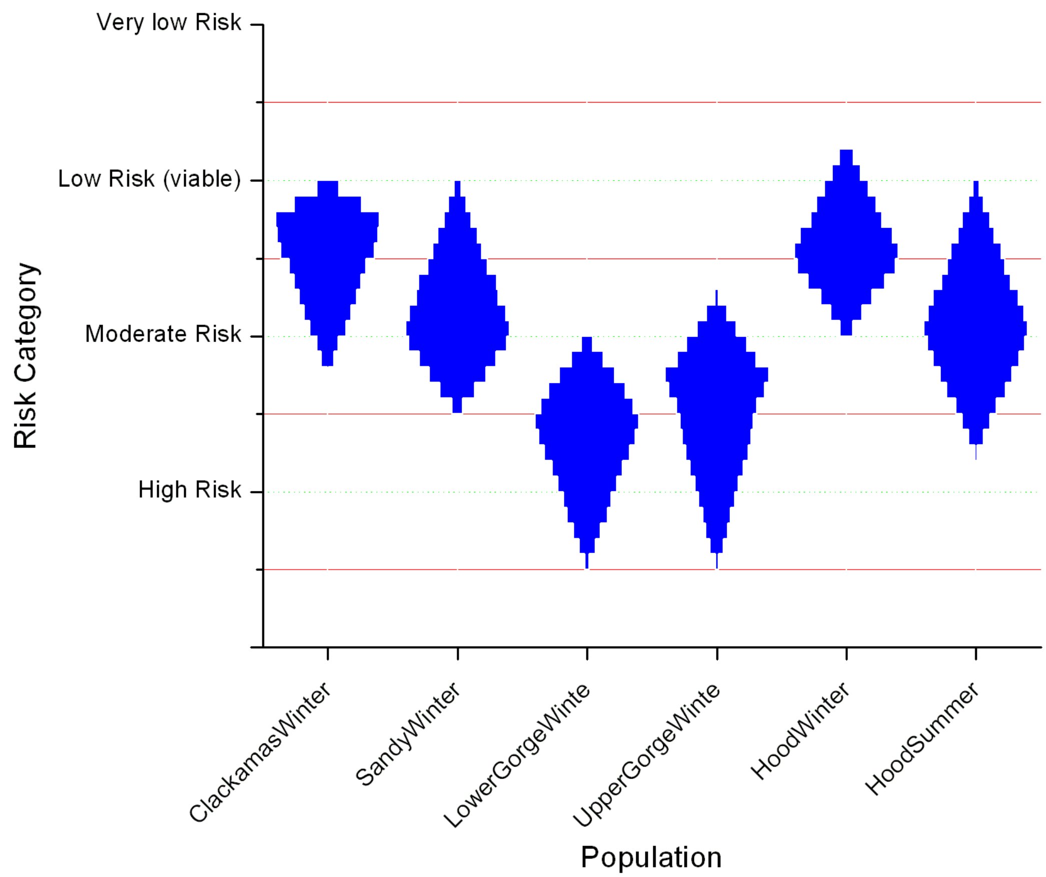

Figure 35: LCR steelhead risk status summary based on evaluation of diversity only.

V. Summary of Population Results

The result we obtained when the scores for all three population criteria were combined was that the risk of extinction for LCR steelhead in Oregon's portion of this DIP was high. Results using the minimum distribution method illustrated by Figure 36 and Figure 37 support this conclusion. A most probable classification for the Clackamas population is low risk. Three of the six populations were clearly in the high risk category. The uncertainty associated with these scores was considerable, as evidenced by the relatively stretched aspect of the diamonds for Hood winter and two gorge populations. However, we conclude that the most probable risk classification for Oregon's LCR steelhead is 'moderate'.

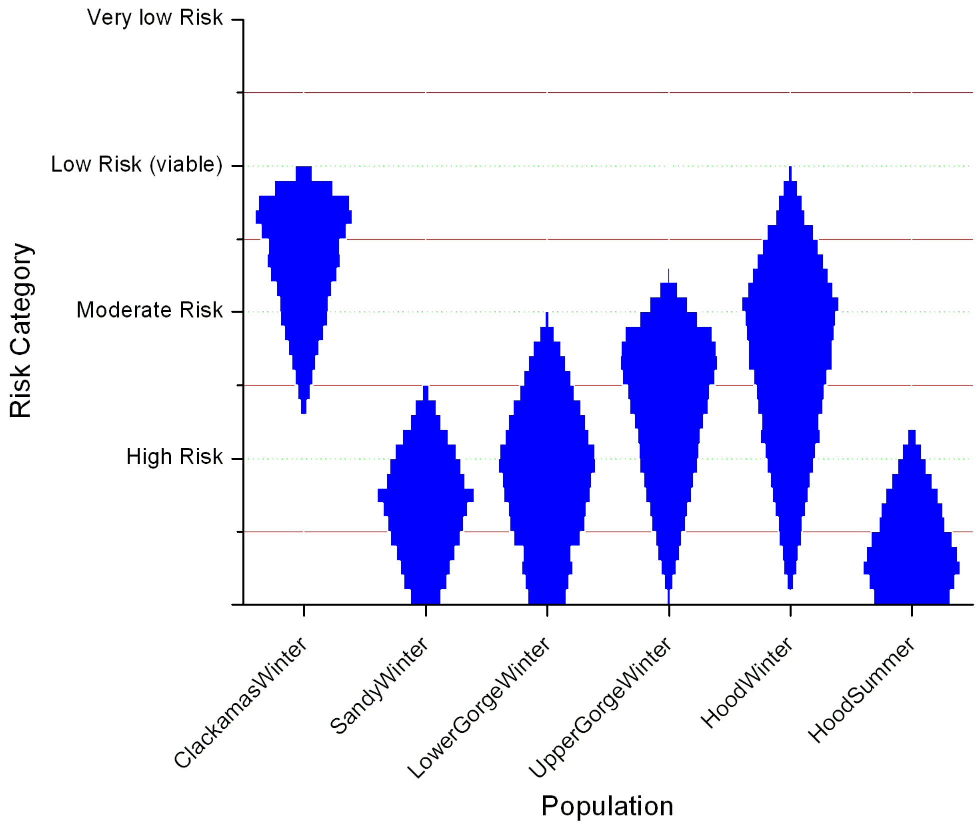

Figure 36: Oregon LCR steelhead population status summaries based on minimum distribution method.

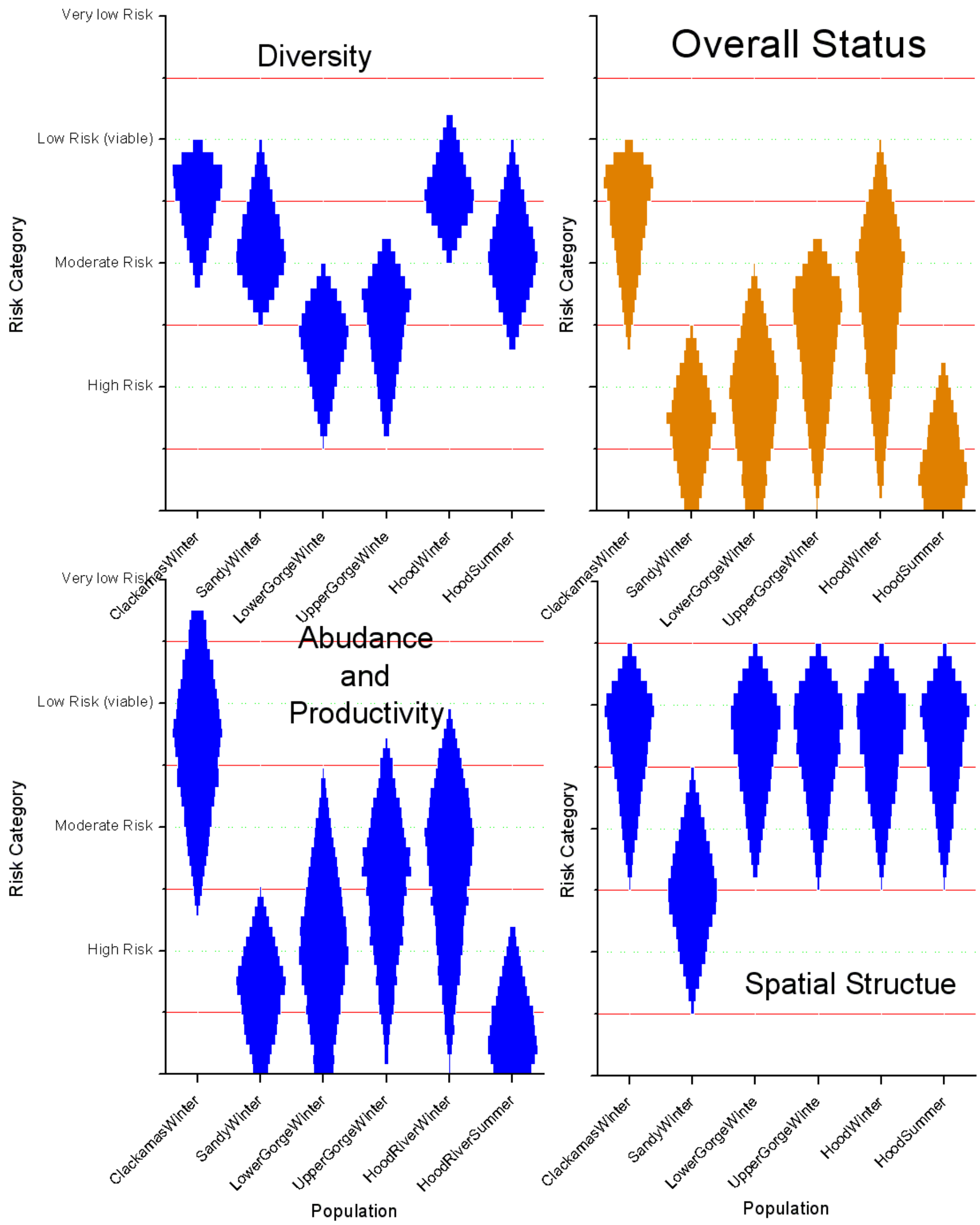

Figure 37: Oregon LCR steelhead status graphs of each attribute and the overall summary.

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